The Labyrinth of Connection: Exploring the Complex Neurobiological Pathway Between Social Exclusion And Academic Anxiety in Adolescents

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Abstract

This review aims to examine the impact of social exclusion and rejection on the brain during adolescence, which often leads to the development of academic anxiety. The brain controls complex bodily functions that allow humans to communicate, feel, remember, and much more. Studies have shown when adolescents face social exclusion/rejection, their brain undergoes biological changes such as an increase in cortisol levels, smaller hippocampus volumes, reduced emotion regulation, and other transformations. These changes can lead to a cognitive decline. During the developing stages, adolescents are more susceptible to peer rejection, which has been shown to potentially impact the brain's parts involved in social interactions. These instances of exclusion can be characterized as traumatic experiences for the students, which can lead to impaired academic performance and academic anxiety. Understanding the link between social exclusion and academic anxiety is key to achieving a productive environment for students where they can safely address their mental health issues and ensure their academic success.

Introduction

Social exclusion and rejection are traumatic events adolescents face that can impact their mental and physical well-being. While Australian research suggests that one in six children faces such experiences, this number may underestimate the actual instances due to the difficulty of measuring the phenomenon. During adolescence, children feel a greater connection with peers, which causes a strong impact when missing. Such instances may be distressing for students as peer relationships involve many complexities [1].
. The biological impacts of such trauma can be seen through detailed and conclusive reviews built on previous research. Four brain regions highlight physiological changes due to rejection. High cortisol levels lead to hippocampus dysfunction, reducing adolescent learning capacity [3]. Research also shows associations between smaller gray matter volume in the parahippocampus and stressors children face, which may lead to cognitive decline [4]. Along with that, abnormal levels of amygdala functioning due to rejection [5] are associated with struggles in emotional regulation [6]. Lastly, the hypothalamus can malfunction in socially excluded children, as seen through abnormally high cortisol levels [7]. With ties to poor academic performance through peer interaction [8] and academic anxiety [9], the brain alterations formed can be indicative of future mental health issues as long-term impacts of such trauma can impact lifestyle and well-being as the possibility of depression [10] and suicidal tendencies [11] increases.

The purpose of the present review is to discuss the potential links between social exclusion and academic anxiety in school-going adolescents. It infers that such anxiety is attained through depleting academic performance using biological changes as a catalyst. By examining crucial research in neuroscience, this paper will give an overview of findings concerning students and their mental health and provide an analytical perspective on the changes parents and teachers could make for the betterment of students [1].

The Basic Function of the Brain & Biological Components of the Brain

The brain oversees numerous body functions. It regulates the stress response, receives sensory information, processes emotions, retains memory, and allows humans to operate as complex beings [12]. The brain is a prominent Central Nervous System (CNS). It consists of the brain and the spinal cord, which take in sensorial input through nerves to process it [13].

Multiple features in the brain support successful cognitive processes. The hippocampus, located in the temporal lobe, manages memory storage, retrieval, and associations [14]. This is done through neurons, or nerve cells, composed of three parts: dendrites, axons, and somas. Dendrites are branch-like structures that receive information from the axons of other cells. The soma is the cell body that holds DNA in the nucleus [15]. The space between adjacent neurons is called the synapse, which facilitates communication between the cells and ultimately determines their connection strength. Frequent signal transmission between neurons makes the synaptic connection more potent, while decreased signaling causes weaker connections to reactivate less frequently and, in certain instances, lead to neuronal death. These neurons convey messages to each other through action potentials and chemical neurotransmitters [16]. The action potentials in a neuron can cause it to release a neurotransmitter that can impact another neuron to fire its action potential [17]. To acquire a higher level of functioning, the brain must make more room for neurons. In such cases, gray matter volumes come into play. Forming the brain surface, gray matter volumes also make up parts of the spinal cord, brainstem, and cerebellum (which oversees brain functions). When the neurons die it indicates a loss of gray matter volume, which can lead to trouble in cognition [18]. One of the causes can be stress, which lessens the network of dendrites along with length and number [19].

Retrieving memory from the hippocampus requires neuron activations that vary in connectivity. Multiple methods can be used to retrieve memory after storage. Recall, for example, stands for regaining memories without triggers that can act as cues. Another technique is recognition, where the brain recognizes previously studied content to make decisions or new experiences. Lastly, relearning involves revisiting a forgotten topic to rekindle memories regarding it [20]. Additionally, there are two types of memory: short-term and long-term. Short-term memory can hold for a small amount of time, while long-term memory can last forever [21]. In a similar suit, there are two categorizations of long-term memory: implicit and explicit. Implicit memory is not intentional and happens automatically. On the other hand, explicit memory (also known as declarative memory) requires conscious recollection and is dependent on the hippocampus and the frontal lobe. Explicit memories also include episodic memory which is in charge of recalling specific events [22]. These different classifications of memory come together to allow humans to function in society, showing the complexity of the hippocampus' part in memory.

Episodic memory also holds close ties to the parahippocampus. Adjacent to the hippocampus, this section has been accredited for forming contextual associations, which can be made spatially or non-spatially. Spatial associations relate to connections made between places and surroundings. They can include specific spaces or details about layouts. Non-spatial associations include objects, behaviors, feelings, people, and many more ideas unrelated to places. These connections are managed through the neural connections the parahippocampus has with the hippocampus and amygdala, and together, they provide a better basis for emotional response. For example, humans can produce empathetic reactions by associating emotional concepts with each other. The process is cyclic/interconnected in that emotional reactions also influence the perception of contexts, such as how people take in facial and body cues to form their understanding of the context presented [23].

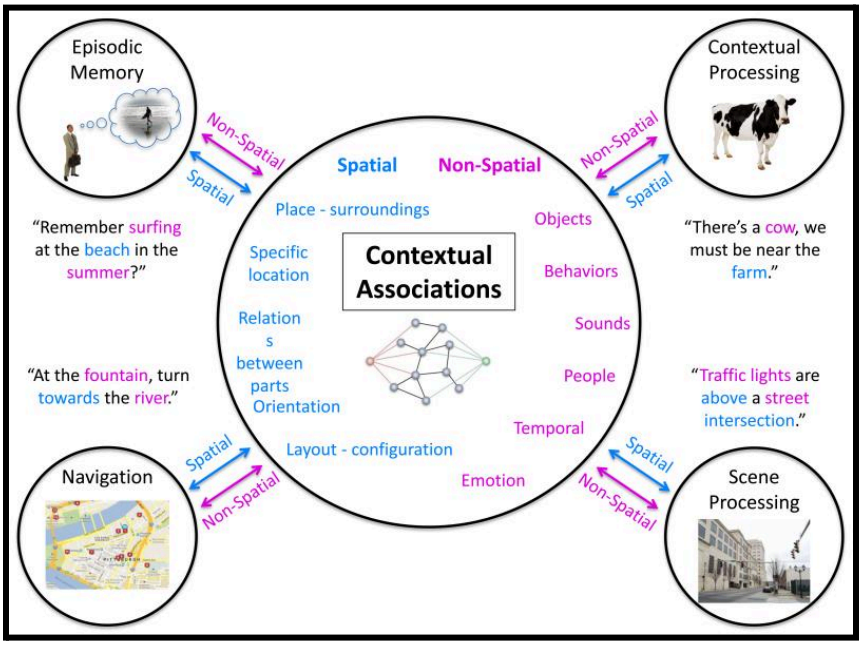

Figure 1: The figure shows the contextual association and the corresponding pathways involved with the association. Spatial associations include connections linked to locations while non-spatial associations refer to objects, sounds, and other non-locational associations. Navigation is an association that engages the parahippocampus through terrain learning. Episodic memory is the memory that by default contains contexts since the memories are of events that include spatial and non-spatial components. Contextual processing represents the idea of inferring connections and scene processing relies on connections between spaces and objects in an environment [23].

The two amygdalae are located bilaterally adjacent to the hippocampus in the temporal lobe. Under stressful circumstances, the amygdala sends a signal to the hypothalamus that alerts the sympathetic nervous system, triggering the fight or flight response to face dangers efficiently. The amygdala also plays a role in managing anxiety and it regulates the stress response to either cause panic or relaxation [24].

The adrenal glands play a role in this reaction as well. Located near the kidneys, these glands release hormones and respond to stress [25]. They release epinephrine or adrenaline, which causes a fast heart rate and high blood pressure. Oxygen intake also becomes more fast-paced to prepare for action like jumping out of the way of an oncoming car [26]. This stimulus reaches the amygdala through the thalamus, passing the information to produce a quick reaction. Afterward, it gradually passes the information to the visual cortex for less attention-demanding decisions. This allows it to take in environmental cues to ensure social awareness [27]. During interactions, the amygdala plays a vital role in articulation and comprehension by interpreting behavior from others based on learned experiences [28].

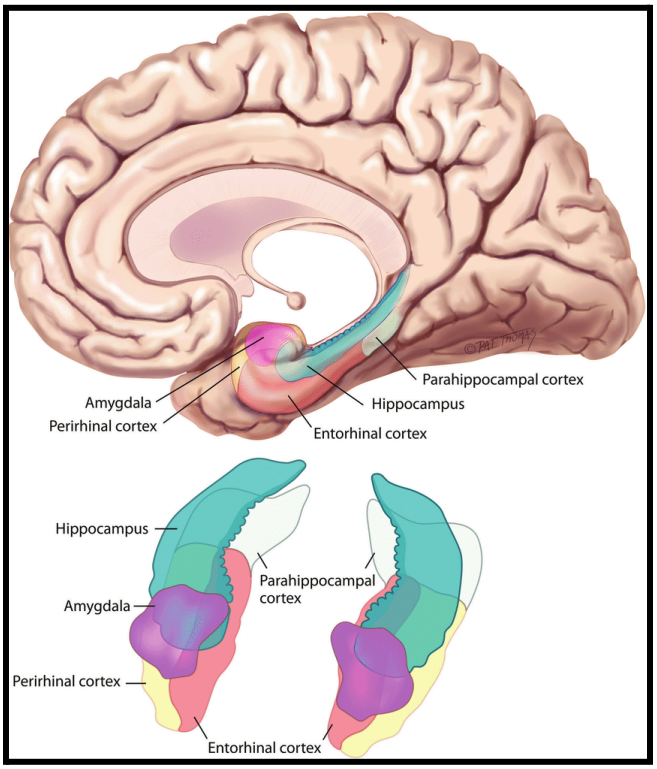

Figure 2: This figure shows the location of the hippocampal cortex, the parahippocampal cortex, and the amygdala in the brain. These parts play active roles in modulating contextual association, memory formation, and social awareness. The entorhinal cortex and perirhinal cortex play active roles in memory and communicating with the hippocampus [29].

The hypothalamus, located near the brain stem, keeps the body in balance by initiating hormone production in the pituitary gland. When the hypothalamus produces the Corticotropin-releasing hormone (CRH), it binds to receptors in the pituitary gland. These receptors are classified as GPCRs (G-protein-coupled receptors that receive signals). After binding, the activation of the G protein allows messages to be sent from the pituitary gland [30, 31]. The gland then releases the Adrenocorticotropic hormone (ACTH) which binds to melanocortin 2 receptors (MC2R) on the exterior of the adrenal zona fasciculata cells. This receptor is also part of a GPCR family containing five members that have different functions [32]. The ACTH hormone allows for the release of cortisol from the adrenal glands while managing metabolism and the immune response [33] thus showing the control the HPA axis (hypothalamus, pituitary gland, and adrenal gland) holds on stress production [34].

During social instances, the hypothalamus has been shown to support sociability and cooperation beyond its initial objective of survival [35]. Oxytocin, a hormone released and stored in the pituitary gland and produced in the hypothalamus [36], may play a role in socioemotional response. Many analyses indicate that intranasal dispensation of oxytocin can increase eye contact between individuals, foster trust, and allow better recognition of facial cues during emotional states [35]. This may be because of how oxytocin specifically targets brain regions that are involved in social interaction, as found in fMRI studies [37] indicating the impact the hormone holds on interaction.

What is Social Exclusion and Rejection?

Adolescents go through multiple stages of social development while growing up, necessitating connections with peers. Erikson's psychosocial stages show that in adolescence (ages 12 to 18) the basic conflict faced by the group is "Identity vs. Confusion". Teens start building their identities and strive to find a role in society through experimentation [38]. By product, teens spend more time with others they find similar interests than their parents. The influence of such groups can shape adolescent behavior and leave them more content as they are better acclimated socially [39]. Cases where such connections do not exist are called social exclusion and rejection. This can be encountered in the school environment, where 1 in 6 students report such conduct, through instances of name-calling, rumor-spreading, and being humiliated deliberately. This leaves a tremendous impact on the mental health of the victim as adolescents are highly responsive to omission due to their progression in the stages of social development [1].

What is Trauma?

To better understand the effects of social exclusion and rejection on the brain, the concept of trauma must be comprehended. Trauma is when mental or physical harm causes a disturbed physiological state [40]. This leads to an abnormal increase in cortisol, which can leave the brain with lasting modifications [41]. Social exclusion and rejection can be classified as a traumatic event that influences the hippocampus, amygdala, and hypothalamus as the regions are highly involved during social events.

Data sets from people with a history of childhood maltreatment (which includes social exclusion) show that social solitariness can negatively impact the gray matter volumes in the parahippocampus contributing to issues with comprehension, motivation, attentiveness, etc [4]. Memory loss is another common symptom of gray matter volume decline caused by trauma [18]. An increase in cortisol is also associated with hippocampal damage. If the high levels remain stagnant, the function of the hippocampus can be negatively impacted, reducing learning through that part of the brain [3]. This can indicate the level of harm social exclusion and rejection can cause hippocampus-based learning in adolescence.

To better examine the involvement of the amygdala during peer rejection, an fMRI study was conducted on participants while playing an online game called Cyberball. In this game, participants were purposefully excluded to simulate peer rejection. This experiment revealed key findings about social exclusion in adolescence. Findings show an increase in amygdala activity after exclusion [5]. Further studies show that due to the amygdala hyperfunctioning for longer than normal, individuals may experience heightened sensitivity to threats. Prolonged activity, however, can cause an overwhelming amount of melancholic feelings and a lack of regulation [6].

The hypothalamus mostly functions along with the HPA axis during social interaction. By examining salivary cortisol, a glucocorticoid hormone, a study found that children facing exclusion had elevated cortisol levels, which implies a functional issue in the HPA axis [42]. This may make it difficult for adolescents to deal with stressors because of the potential of developing a disorder like bulimia or overeating, a condition associated with higher levels of cortisol, that gets in the way of daily life [43]. It can also cause students issues with retention and focus as high levels of cortisol can impact cognition. Lastly, the increase of cortisol can affect the basolateral complex of the amygdala (BLA), a segment involved in anxiety and

retention. The heightened glucocorticoid hormone circulation can cause memory retrieval issues as the BLA regulates stress [44].

What is Academic Performance?

Due to the classification of social exclusion and rejection as traumatic experiences [45], traumatic events can impact considerable aspects of a child's life. As school consumes most of a child's time, socially excluded students face unique challenges that can alter their academic performance. Academic performance can be defined through standardized test scores, academic mindsets, goal setting/achieving, and grade point averages [46]. Standardized tests include the SAT and ACT, the scores from which are used by most colleges for the admissions process. The SAT exam has math and reading/writing sections, each worth 800 points, to create a total score of 1600 [47]. The total score for the ACT score is 36, and topics include math, reading, English, and science. The average SAT score is 1060 among high-school students in the US, while the average ACT score is 21[48].

Besides exams, research has shown that evaluating mindsets provides a better look into beliefs a student must have to 'perform better' academically. These beliefs include a sense of belonging, a growth mindset, a need to succeed, and an understanding of the value of work [49]. Looking into grade point average (GPA), it is found by first taking the grade received in a class and multiplying it by the credits it was worth. After doing that for all courses, the numbers are added together and divided by the total amount of credits [51]. The national student norm is 3.0 on a 4.0 scale [52]. This equals an average B or 84 - 86% [53]. This average may influence a student's academic performance as it can determine their success through an exhibition of mastery and mindset.

What is Academic Anxiety?

Academic anxiety is stress and worry affiliated with assignments, tests, and societal pressures in education. Small spans of such anxiety benefit students as it urges them to push forward. This particular type of anxiety is known as facilitative anxiety [54]. Anything beyond normal nervousness can harm students in their academic and personal lives. Academic anxiety functions as a cycle; when a stressor (like a test) comes closer in time, anxiety spikes, but after the test the anxiety depletes until another stressor arises.

The symptoms of academic anxiety can be divided into three sub-groups named after the region they dominate: physiological, cognitive, and behavioral [54]. Physiological symptoms of academic anxiety manifest physically making parts of the body feel nervous. This includes nausea, elevated heart rate, headaches, sweating, shortness of breath, and muscle tension. Those facing such symptoms often use relaxation methods like mindfulness to regain awareness in the body and release worry. Cognitive symptoms revolve around thoughts and negative thinking processes. The procedures can cause students to become unfocused and lost in their introspections. Common effects include lack of attentiveness, memory retrieval blockage, and negative self-talk. Relaxation methods alongside techniques like time management, organization, and study habit formation can reduce the impact of the symptoms. Mindfulness also helps combat negativity in students, allowing them to reflect and maintain focus. Behavioral symptoms are based on conduct and practices. Students may engage in behaviors that allow them to avoid certain tense situations. These can include procrastination in stressful projects, less effort being put into work, distraction through other tasks, and simply

giving up. To combat this, many students use planners and set specific study times to avoid putting tasks off.

Though not fully a category, social academic anxiety focuses on the aspects of stress caused by peers, family, and societal expectations. Not meeting a goal can cause family members to get upset, peers to inflict shame, and society to look down on students. This can also be one of the causes of academic anxiety. As a method of improvement, students are encouraged to participate in positive self-talk that boosts their esteem. Similarly, teachers are motivated to convey that grades do not dictate the students' value as a person, bringing down the pressure in the school environment. These types of anxiety symptoms and potential causes can manifest at any age and require exploration to find techniques that work best for each student [55].

Academic Performance & Anxiety for Students Facing Social Exclusion and Rejection

When understood as a whole idea, social exclusion/rejection has negative impacts on the brain and has the potential to cause academic anxiety due to lower academic performance. The decrease in academic performance can be accredited to the different impacted areas of the brain used in school settings. These areas can be retention [56], focus [44], emotion regulation [24], stress management [44], and cognition [18].

The hippocampus deals with memory and retention, which students heavily rely on during examinations like standardized tests. It allows students to recall and find applications for their understanding over time, creating a foundation learners can build upon to improve their academic level and enhance skills like critical thinking and problem-solving. Due to the accumulative nature of school subjects over grade levels, a lack of retentive ability can confuse students in applying their learnings, consequently leaving them unmotivated [57].

Gray matter volume decline in the parahippocampus can be another explanation for a drop in GPA due to failing test scores. The parahippocampus aids in cognition (the grasping of knowledge using thinking, experiences, and senses [58]) through contextual associations that are spatial (spaces and locations) and non-spatial (anything besides locations) (23). A gray matter volume decrease can be seen as harmful to attentiveness and cognition [4]. Focus, defined as giving attention to an activity, is a specific contributing factor to learning as it allows for understanding new information [59]. Learning tasks that are completed through deep focus are known as deep work while less demanding activities that can be done without intense focus are known as shallow work. Deep work can be seen as going through challenging content and solving complex academic problems [60]. Without such a deep work style of focus, students have difficulty grasping curriculum content [61] which can put them at risk for a lower grade [62] that impacts GPA.

Prolonged exclusion can increase amygdala functioning, causing heightened sensitivity in many settings [6]. Social cues can be misunderstood through the lack of perceptive abilities impacting peer relationships [63]. This hinders cooperation with other students following a lowered academic performance. A particular study examines cooperation through an activity with children as participants. This activity was similar to the Prisoner's Dilemma, a game where players are put in a situation where they must choose between cooperation or winning at the expense of the player they are paired with. This game represents the losses or profits achieved through decision-making [64]. The students have to act in self-interest or choose another option with mutual benefit [65]. Researchers gained better insight into the interactions of students with whom they share a positive or negative history. In other parts of the study, it was found that

students who engaged in high levels of cooperative interactions showed significantly higher GPAs encapsulating the influence of collaboration [8].

Due to increased cortisol production during instances of exclusion, the hypothalamus, pituitary gland, and adrenal glands can display issues in functioning [42]. Cortisol production also has an impact on hedonic and homeostatic appetite drive. Homeostatic pathways function as motivation drives towards eating after energy loss. Hedonic pathways overpower homeostatic pathways to promote the consumption of more appealing foods [66]. Reward anticipation depletes on a neural level after high cortisol levels [67] and punishment is often linked to low cortisol levels [68]. Alongside that, changes in metabolism (conversion of food to energy [69]) and general/eating-related psychopathology also face changes. Psychopathology refers to the study of mental health issues and their causes, symptoms, types, behaviors, and many more related topics [70]. Eating-related psychopathology specifically refers to eating disorders that can include issues over body image, diet restriction, etc [71]. To briefly summarize the findings of the studies, a correlation was found between people with anorexia nervosa (an eating disorder) and high daily rates of cortisol [43]. Students with eating disorders can have difficulty in concentration and information processing in classrooms resulting in lower academic performance. It also facilitates a negative view of socializing in those suffering as their relationships with teachers and peers deteriorate [72]. All of these factors can contribute significantly to a student's academic performance which can be linked to academic anxiety.

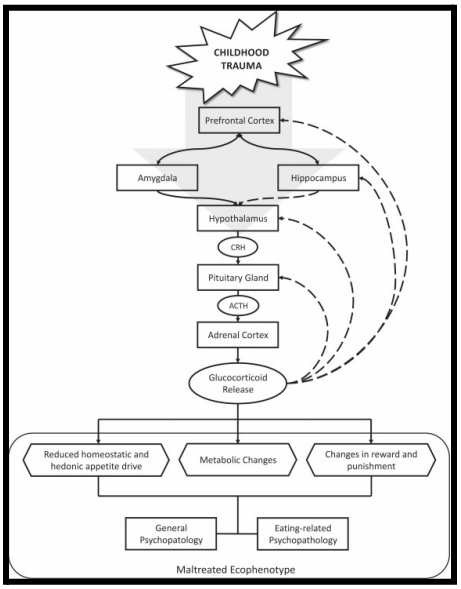

Figure 3: This figure is a diagram depicting the involvement of the HPA axis with glucocorticoid release. The release is connected to eating-related psychopathology along with reduced homeostatic and hedonic appetite drive, metabolic changes, changes in reward and punishment, and general psychopathology [43**].**

Poor academic performance can be seen as a trigger for academic anxiety in adolescents. A particular paper presented the findings of a meta-analysis on the relationship between academic performance and academic anxiety. The paper found that in a meta-analysis of 26 studies, a negative correlation between students' performance in mathematics and their academic anxiety had formed. Similarly, the findings of a meta-analysis of 34 studies with 16275

participants show that poor readers felt a higher level of academic anxiety compared to others. A model of understanding the findings is that poor achievement leads to higher anxiety. This explanation suggests that academic anxiety is a response to academic failure at school. The failing streaks and environmental pressures push for improvement, which can cause fear and anxiety in learners. Another model, however, sports the opposite approach. Academic anxiety can be seen as a contributing factor to poor academic performance, which can be called the cognitive interference theory at times due to the lack of attentiveness in students. Physical symptoms of anxiety, like stomach pain, can cause students to stay home from school. Those with symptoms like avoidance of emotions can lead to students missing out on crucial learning and opportunities. A third model explains that students facing struggles can develop anxiety that causes greater stress, which can further cause harm to their performance leading to a continuous cycle. This cycle can be noticed in the biopsychosocial model as well, noting the impact of cognitive, physical, and social impact on academic anxiety. The overall goal of this model is to note that academic anxiety can be triggered through subpar performance but also vice versa [9].

Long Term Consequences

Academic performance and anxiety can majorly impact many other areas as well. Researchers from the Office of Educational Research and Improvement (OERI) discussed the students' beliefs regarding academic achievement during a conference. While some students are high achieving and credit their abilities for their grades, those who are performing poorly avoid putting in effort in case they get a low grade though they worked hard [73]. It can be said that low self-esteem in students can lead them not to try at all and avoid challenging work. The negative development of coping mechanisms regarding failures can lessen a student's desire to learn. This lack of confidence begins with failing test scores or negative feedback that makes a student not want to try again [74].

Besides school settings, self-esteem plays a vital role in long-term success. Researchers took data from numerous longitudinal studies and found that high self-esteem can foster positive relationships, better mental and physical states, and lead people away from anti-social activity. These impacts last from childhood to adulthood and onwards. Researchers have also laid out the differences between narcissism and high self-esteem. Reviews add that a narcissist's superiority cannot be seen as synonymous with self-respect, often seen in those with high self-esteem. On a large scale, high self-esteem is seen as a characteristic in people that can be used for the betterment of society [75].

Anxiety disorders like academic anxiety can also lead to or worsen other issues including depression, suicidal tendencies, insomnia (issues with sleeping), headaches, chronic pain, etc [11]. Depression is defined as a mental illness that affects thoughts, emotions, behaviors, and perceptions in a negative way [76]. Clinical depression, also called major depression, can harm other aspects of lifestyles as well. Conditions such as hypertension, coronary artery disease, and diabetes can also be worsened or increasingly challenging to manage. Additionally, individuals with depression are at higher risk for substance use disorders, which can consequently increase the risk for suicidal ideation and undeniably impact their quality of life [10].

CONCLUSION

Through the various findings above, many connections can be made regarding correlations and similarities in data. As discussed before, the biological impacts of social exclusion and rejection on the hippocampus [3], parahippocampus [4], amygdala [6], and hypothalamus [7] are linked with academic performance in children. As hypothesized, a decrease in academic performance is associated with physiological changes in the brain due to exclusion. This can be seen through the changes in cognition and motivation [4], lack of emotional regulation [6], increased risk of eating disorders [43], and memory deficits [44]. All of these transformations can be related to the areas used in school for learning such as retention [57], focus [61], cooperation [8], and socialization with teachers and peers [72]. Academic anxiety has been closely related to poor academic performance. Multiple models show relationships between the two and how they impact each other [9], facilitating the connection needed to study social exclusion and rejection as a possible cause of academic anxiety.

Although multiple research papers have been analyzed in this review, it is important to note the limitations of the inferences. Measuring social exclusion in school settings requires discrete and arduous methods, so it is possible that the figures found underrepresent the number of students who face exclusion [1]. Another limitation may be the schooling style of the students. This review used data from students at traditional schools with curriculums based on classes, memorization, and testing [77]. Non-traditional schooling, such as Acton Academy, is set at a pace that accommodates students while focusing on the growth of self-directed learning [78]. Some limitations of the studies included observational data, lack of diversity, and small sample sizes, which can affect the application of the data.

To encourage further analysis, a study on socially excluded students and their academic performance is beneficial for deriving accurate conclusions. This allows researchers to see neurological activity in excluded students in school and compare it to other students. The control provides a space to view changes that can result from the peer rejection itself.

Moving forward, there are many steps teachers and parents can take to avoid exclusion in school settings. During such exclusion, children may need a listening ear. It is recommended that they be genuine and affirming to provide them security while making the home a place free from exclusion. One way is through monitoring technology to avoid cyberbullying and exclusion online. Stress management methods can also be used during distressing events. Teachers can form environments at school that implement respect toward peers, active communication, and teamwork. Encouraging other students to intervene while discussing the moral essence of social exclusion can foster a positive environment that promotes student growth.

Reflecting on this research, it is clear that such events can cause significant changes in the lives of students, teachers, and society. By taking on preventative measures of exclusion and targeting preexisting themes of such rejection in school, educators, parents, and society can take a step towards a healthier and more inclusive future.

References

1. Rocker, Leonardo. “Social Exclusion at School.” *Www.childpsychologist.com.au*, www.childpsychologist.com.au/resources/social-exclusion-at-school.

2. Eisenberger, N. I., et al. “Does Rejection Hurt? An FMRI Study of Social Exclusion.” *Science*, vol. 302, no. 5643, 10 Oct. 2003, pp. 290–292, https://doi.org/10.1126/science.1089134.

3. Sroykham, Watchara, and Yodchanan Wongsawat. “Effects of Brain Activity, Morning Salivary Cortisol, and Emotion Regulation on Cognitive Impairment in Elderly People.” *Medicine*, vol. 98, no. 26, June 2019, p. e16114, www.ncbi.nlm.nih.gov/pmc/articles/PMC6616250/#:~:text=Basal%20cortisol%20elevation%20causes%20damage,frontal%20lobe%20in%20the%20brain., https://doi.org/10.1097/md.0000000000016114.

4. Lim, Lena, et al. “Gray Matter Abnormalities in Childhood Maltreatment: A Voxel-Wise Meta-Analysis.” *American Journal of Psychiatry*, vol. 171, no. 8, Aug. 2014, pp. 854–863, https://doi.org/10.1176/appi.ajp.2014.13101427.

5. Masten, Carrie L., et al. “Neural Correlates of Social Exclusion during Adolescence: Understanding the Distress of Peer Rejection.” *Social Cognitive and Affective Neuroscience*, vol. 4, no. 2, 26 May 2009, pp. 143–157, academic.oup.com/scan/article/4/2/143/1627500, https://doi.org/10.1093/scan/nsp007.

6. Gerin, Mattia I., et al. “Heightened Amygdala Reactivity and Increased Stress Generation Predict Internalizing Symptoms in Adults Following Childhood Maltreatment.” *Journal of Child Psychology and Psychiatry*, vol. 60, no. 7, Apr. 2019, pp. 752–761, https://doi.org/10.1111/jcpp.13041.

7. Dickerson, S. “APA PsycNet.” *Psycnet.apa.org*, 2013, psycnet.apa.org/record/2012-26299-014.

8. Víctor Landaeta Torres. “Using Experimental Game Theory to Measure Cooperative Relations in Elementary School Classrooms to Understand Its Relationship with Academic Performance and School Climate.” *Scispace*, 1 Jan. 2022, typeset.io/papers/using-experimental-game-theory-to-measure-cooperative-2qmq49l8, https://doi.org/10.52611/11447/6151.

9. Fishstrom, Sarah, et al. “A Meta-Analysis of the Effects of Academic Interventions on Academic Achievement and Academic Anxiety Outcomes in Elementary School Children.” *Journal of School Psychology*, vol. 92, June 2022, pp. 265–284, https://doi.org/10.1016/j.jsp.2022.03.011.

10. “Clinical Depression (Major Depressive Disorder): Symptoms.” *Cleveland Clinic*, 30 Nov. 2022,

my.clevelandclinic.org/health/diseases/24481-clinical-depression-major-depressive-disorder.

11. Mayo Clinic Staff. “Anxiety Disorders.” *Mayo Clinic*, Mayo Foundation for Medical Education and Research, 4 May 2018, www.mayoclinic.org/diseases-conditions/anxiety/symptoms-causes/syc-20350961.

12. “Brain: Anatomy, Development and Function.” *Cleveland Clinic*, Cleveland Clinic, 30 Mar. 2022, my.clevelandclinic.org/health/body/22638-brain.

13. “Central Nervous System: What Does It Do?” *Cleveland Clinic*, 12 Nov. 2023, my.clevelandclinic.org/health/body/central-nervous-system-cns.

14. Kendra Cherry. “How Important Is the Hippocampus in the Brain?” *Verywell Mind*, 18 Oct. 2022, www.verywellmind.com/what-is-the-hippocampus-2795231.

15. Woodruff, Alan. “What Is a Neuron?” *Uq.edu.au*, The University of Queensland, 2018, qbi.uq.edu.au/brain/brain-anatomy/what-neuron.

16. “How Are Memories Formed?” *Qbi.uq.edu.au*, 2 Dec. 2016, qbi.uq.edu.au/brain-basics/memory/how-are-memories-formed#:~:text=Different%20groups%20of%20neurons%20

17. Queensland brain institute. “Action Potentials and Synapses.” *The University of Queensland*, 2024, qbi.uq.edu.au/brain-basics/brain/brain-physiology/action-potentials-and-synapses.

18. “Grey Matter.” *Cleveland Clinic*, 19 Mar. 2023, my.clevelandclinic.org/health/body/24831-grey-matter.

19. Ansell, Emily B., et al. “Cumulative Adversity and Smaller Gray Matter Volume in Medial Prefrontal, Anterior Cingulate, and Insula Regions.” *Biological Psychiatry*, vol. 72, no. 1, July 2012, pp. 57–64, https://doi.org/10.1016/j.biopsych.2011.11.022. Accessed 18 Jan. 2021.

20. OpenStax, and Lumen Learning. “Retrieval.” *Pressbooks.online.ucf.edu*, pressbooks.online.ucf.edu/lumenpsychology/chapter/reading-retrieval/#:~:text=There%20are%20three%20ways%20you.

21. Bisaz, Reto, et al. “The Neurobiological Bases of Memory Formation: From Physiological Conditions to Psychopathology.” *Psychopathology*, vol. 47, no. 6, 2014, pp. 347–356, www.ncbi.nlm.nih.gov/pmc/articles/PMC4246028/, https://doi.org/10.1159/000363702.

22. https://www.facebook.com/verywell. “What’s the Difference between Implicit and Explicit Memory?” *Verywell Mind*, 2024,

www.verywellmind.com/implicit-and-explicit-memory-2795346#:~:text=Implicit%20memory%20and%20explicit%20memory%20are%20both. Accessed 26 Aug. 2024.

23. Aminoff, Elissa M., et al. "The Role of the Parahippocampal Cortex in Cognition." *Trends in Cognitive Sciences*, vol. 17, no. 8, Aug. 2013, pp. 379–390, https://doi.org/10.1016/j.tics.2013.06.009.

24. Wendt, Taylor. "Amygdala: What to Know." *WebMD*, 1 Sept. 2022, www.webmd.com/brain/amygdala-what-to-know.

25. Cleveland Clinic. "Adrenal Gland: What It Is, Function, Symptoms & Disorders." *Cleveland Clinic*, 2022, my.clevelandclinic.org/health/body/23005-adrenal-gland.

26. Publishing, Harvard Health. "Understanding the Stress Response." *Harvard Health*, 6 July 2020, www.health.harvard.edu/staying-healthy/understanding-the-stress-response#:~:text=The%20autonomic%20nervous%20system%20has.

27. "Limbic System: Amygdala (Section 4, Chapter 6) Neuroscience Online: An Electronic Textbook for the Neurosciences | Department of Neurobiology and Anatomy - the University of Texas Medical School at Houston." *Tmc.edu*, 2020, nba.uth.tmc.edu/neuroscience/m/s4/chapter06.html#:~:text=On%20the%20other%20hand%2C%20pathways. Accessed 28 Aug. 2024.

28. ---. "The Amygdala: A Small Part of Your Brain's Biggest Abilities." *Cleveland Clinic*, 11 Apr. 2023, my.clevelandclinic.org/health/body/24894-amygdala.

29. "FIG 1. The Medial Temporal Lobe Consists of the Hippocampal Formation..." *ResearchGate*, www.researchgate.net/figure/The-medial-temporal-lobe-consists-of-the-hippocampal-formation-blue-green-superiorly_fig5_268791398.

30. Chidambaram, Hariharakrishnan, and Subashchandrabose Chinnathambi. "G-Protein Coupled Receptors and Tau-Different Roles in Alzheimer's Disease." *Neuroscience*, vol. 438, 1 July 2020, pp. 198–214, www.sciencedirect.com/science/article/abs/pii/S0306452220302414, https://doi.org/10.1016/j.neuroscience.2020.04.019.

31. "GPCR | Learn Science at Scitable." *Nature.com*, 2014, www.nature.com/scitable/topicpage/gpcr-14047471/#:~:text=Conclusion.

32. Angelousi, Anna, et al. "ACTH Action on the Adrenals." *PubMed*, MDText.com, Inc., 2000, www.ncbi.nlm.nih.gov/books/NBK279118/#:~:text=ACTH%20binds%20to%20the%20highly.

33. ---. “Hypothalamus: What It Is, Function, Conditions & Disorders.” *Cleveland Clinic*, 16 Mar. 2022, my.clevelandclinic.org/health/body/22566-hypothalamus.

34. Thau, Lauren, et al. “Physiology, Cortisol.” *National Library of Medicine*, StatPearls Publishing, 2023, www.ncbi.nlm.nih.gov/books/NBK538239/.

35. Caria, Andrea, and Ginevra Matilde Dall’Ò. “Functional Neuroimaging of Human Hypothalamus in Socioemotional Behavior: A Systematic Review.” *Brain Sciences*, vol. 12, no. 6, 30 May 2022, p. 707, https://doi.org/10.3390/brainsci12060707.

36. ---. “Oxytocin: What It Is, Function & Effects.” *Cleveland Clinic*, Cleveland Clinic, 27 Mar. 2022, my.clevelandclinic.org/health/articles/22618-oxytocin.

37. Bethlehem, Richard A. I., et al. “Oxytocin, Brain Physiology, and Functional Connectivity: A Review of Intranasal Oxytocin FMRI Studies.” *Psychoneuroendocrinology*, vol. 38, no. 7, 1 July 2013, pp. 962–974, www.sciencedirect.com/science/article/abs/pii/S0306453012003460, https://doi.org/10.1016/j.psyneuen.2012.10.011.

38. Mcleod, Saul. “Erik Erikson’s Stages of Psychosocial Development.” *Simply Psychology*, 2024, www.simplypsychology.org/Erik-Erikson.html.

39. “Social Development during Adolescence | Lifespan Development.” *Courses.lumenlearning.com*, courses.lumenlearning.com/wm-lifespandevelopment/chapter/social-development-during-adolescence/.

40. Merriam-Webster. “Definition of TRAUMA.” *Merriam-Webster.com*, 2019, www.merriam-webster.com/dictionary/trauma.

41. Bremner, J Douglas. “Traumatic Stress: Effects on the Brain.” *Dialogues in Clinical Neuroscience*, vol. 8, no. 4, 8 Dec. 2006, pp. 445–61, www.ncbi.nlm.nih.gov/pmc/articles/PMC3181836/, https://doi.org/10.31887/DCNS.2006.8.4/jbremner.

42. Peters, Ellen, et al. “Peer Rejection and HPA Activity in Middle Childhood: Friendship Makes a Difference.” *Child Development*, vol. 82, no. 6, 25 Oct. 2011, pp. 1906–1920, https://doi.org/10.1111/j.1467-8624.2011.01647.x.

43. Cascino, Giammarco, and Alessio Maria Monteleone. “Early Traumatic Experiences and the Hypothalamus-Pituitary-Adrenal Axis in People with Eating Disorders: A Narrative Review.” *Psychoneuroendocrinology*, vol. 159, 1 Jan. 2024, pp. 106665–106665, https://doi.org/10.1016/j.psyneuen.2023.106665.

44. Hinds, Jenalee A., and Edwin R. Sanchez. “The Role of the Hypothalamus–Pituitary–Adrenal (HPA) Axis in Test-Induced Anxiety: Assessments,

Physiological Responses, and Molecular Details." *Stresses*, vol. 2, no. 1, 14 Mar. 2022, pp. 146–155, www.mdpi.com/2673-7140/2/1/11#:~:text=A%20psychological%20stressor%20can%20activate,an%20increase%20in%20anxiety%20levels., https://doi.org/10.3390/stresses2010011.

45. Brenda, Dater. "Exclusion and Trauma." *Aane.org*, 3 Nov. 2022, aane.org/autism-info-faqs/library/exclusion-and-trauma/.

46. Farb, Amy. "Academic Performance - an Overview | ScienceDirect Topics." *Www.sciencedirect.com*, 2012, www.sciencedirect.com/topics/psychology/academic-performance.

47. Princeton Review. "What Is the SAT? | the Princeton Review." *Princetonreview.com*, 2019, www.princetonreview.com/college/sat-information.

48. The Princeton Review. "What Is the ACT? | the Princeton Review." *Princetonreview.com*, 2000, www.princetonreview.com/college/act-information.

49. "Academic Mindset." *Mindsetworks.com*, 2017, www.mindsetworks.com/go/academic-mindsets/#:~:text=What%20are%20Academic%20Mindsets?

50. Mindmesh. "What Is Goal Setting – Definition, Process & Examples | Mindmesh." *Www.mindmesh.com*, 2023, www.mindmesh.com/glossary/what-is-goal-setting.

51. Potter, Kevin. "What Is a GPA and Why Is It so Important? - MastersPortal.com." *Mastersportal.com*, 22 Dec. 2017, www.mastersportal.com/articles/2126/what-is-a-gpa-and-why-is-it-so-important.html.

52. Lindsay, Samantha. "What's the Average High School GPA? · PrepScholar." *Prepscholar.com*, 2018, blog.prepscholar.com/whats-the-average-high-school-gpa#:~:text=As%20you%20can%20see%2C%20the%20national%20overall%20average%20GPA%20is%203.0.

53. "How to Calculate Your GPA." *Www.princetonreview.com*, www.princetonreview.com/college-advice/gpa-college-admissions.

54. "About Academic Anxiety." *Academic Anxiety Resource Center*, sites.bsu.edu/aarc/about-academic-anxiety/#:~:text=Academic%20anxiety%20refers%20to%20the.

55. Rincon, Keeli R. "Types of Academic Anxiety." *Academic Anxiety Resource Center*, 12 Nov. 2021, sites.bsu.edu/aarc/2021/11/12/types-of-academic-anxiety/.

56. ---. “Hippocampus: What’s Its Function?” *Cleveland Clinic*, 14 May 2024, my.clevelandclinic.org/health/body/hippocampus.

57. Learning, Think, and Laura Caveney. “9 Strategies to Improve Learning Retention.” *Think Learning*, 6 Oct. 2023, www.think-learning.com/learning-impact/learning-retention/.

58. Mak, Ying. “What Is Cognition?” *Cambridge Cognition*, 19 Aug. 2015, cambridgecognition.com/what-is-cognition/.

59. Cambridge Dictionary. “Focus.” *@CambridgeWords*, 28 Aug. 2024, dictionary.cambridge.org/dictionary/english/focus#google_vignette.

60. “How to Focus for Learning.” *Physiopedia*, www.physio-pedia.com/How_to_Focus_for_Learning.

61. Le, Manh Hung, et al. “Smart Desk in Hybrid Classroom: Detecting Student’s Lack of Concentration When Studying.” *IEEE Xplore*, 1 Oct. 2022, ieeexplore.ieee.org/abstract/document/10013468.

62. Wheeler, Resa S., and Marie Emerald A. Cabigas. “Pupils’ Focus and Motivations: Their Influence on Mathematics Performance.” *INTERNATIONAL JOURNAL of MULTIDISCIPLINARY RESEARCH and ANALYSIS*, vol. 07, no. 06, 11 June 2024, typeset.io/papers/pupils-focus-and-motivations-their-influence-on-mathematics-522mf1pft0, https://doi.org/10.47191/ijmra/v7-i06-04.

63. Neumeister, P., et al. “Specific Amygdala Response to Masked Fearful Faces in Post-Traumatic Stress Relative to Other Anxiety Disorders.” *Psychological Medicine*, vol. 48, no. 7, 27 Sept. 2017, pp. 1209–1217, www.cambridge.org/core/journals/psychological-medicine/article/specific-amygdala-response-to-masked-fearful-faces-in-posttraumatic-stress-relative-to-other-anxiety-disorders/BEB5AC06F46320E00B82E2185629804A, https://doi.org/10.1017/s0033291717002513.

64. Chappelow, Jim. “Prisoner’s Dilemma Definition.” *Investopedia*, 23 May 2019, www.investopedia.com/terms/p/prisoners-dilemma.asp.

65. Frantz, Roger. “X-Efficiency. An Intervening Variable.” *Elsevier EBooks*, 11 Oct. 2019, pp. 95–116, www.sciencedirect.com/topics/economics-econometrics-and-finance/prisoner-dilemma, https://doi.org/10.1016/b978-0-12-815289-8.00006-x.

66. Lutter, Michael, and Eric J. Nestler. “Homeostatic and Hedonic Signals Interact in the Regulation of Food Intake.” *The Journal of Nutrition*, vol. 139, no. 3, 28 Jan. 2009, pp. 629–632, https://doi.org/10.3945/jn.108.097618.

67. Kinner, Valerie L., et al. “Cortisol Alters Reward Processing in the Human Brain.” *Hormones and Behavior*, vol. 84, Aug. 2016, pp. 75–83, https://doi.org/10.1016/j.yhbeh.2016.05.005.

68. Honk, Jack van, et al. “Low Cortisol Levels and the Balance between Punishment Sensitivity and Reward Dependency.” *NeuroReport*, vol. 14, no. 15, Oct. 2003, pp. 1993–1996, https://doi.org/10.1097/00001756-200310270-00023.

69. Hirsch, Larissa. “Metabolism (for Teens) - KidsHealth.” *Kidshealth.org*, July 2019, kidshealth.org/en/teens/metabolism.html.

70. Cuncic, Arlin. “What Exactly Is Psychopathology?” *Verywell Mind*, 2020, www.verywellmind.com/an-overview-of-psychopathology-4178942.

71. Ng, KW, et al. “Eating Psychopathology and Psychosocial Impairment in Patients Treated at a Singapore Eating Disorders Treatment Programme.” *Singapore Medical Journal*, vol. 59, no. 1, Jan. 2018, pp. 33–38, https://doi.org/10.11622/smedj.2017042.

72. “Eating Disorders and the School Setting.” *Aap.org*, 2020, www.aap.org/en/patient-care/school-health/mental-health-in-schools/eating-disorders-and-the-school-setting/?srsltid=AfmBOornIH8qufZcfq6GetxlwQcRBo57KpPtk3852kx9tpI0fb4xaHgx.

73. Tomlinson, Tommy M. “Hard Work and High Expectations.” *Google Books*, 2024, books.google.co.in/books?hl=en&lr=&id=9Gqt5ueCAkUC&oi=fnd&pg=PA1&dq=are+students+willing+to+take+harder+classes&ots=5Jwb1j4YoD&sig=QJKTixwuRNuwJ_fva4eJyL5Cej8&redir_esc=y#v=onepage&q=are%20students%20willing%20to%20take%20harder%20classes&f=false.

74. Camel, Dawn. *Improving Student’s Academic Performance from the Inside Out: The Relationship between Self-Esteem and Academic Performance a RESEARCH SNAPSHOT*. June 2020.

75. Blouin, Melissa. “Research Review Shows Self-Esteem Has Long-Term Benefits.” *UC Davis*, 15 Apr. 2022, www.ucdavis.edu/curiosity/news/research-review-shows-self-esteem-has-long-term-benefits.

76. Onyemaechi, Chinenye . “What Is Depression?” *American Psychiatric Association*, Apr. 2024, www.psychiatry.org/patients-families/depression/what-is-depression.

77. “What Is Non-Traditional Education?” *The American Academy*, 2024, www.theamericanacademy.com/blogs/articles/what-is-non-traditional-education.

78. Acton. “Acton Academy.” *Acton Academy*, 2014, www.actonamba.org/faqs.