Synaptic Pruning in Adolescence: Mechanisms, Environmental Influences, and Behavioral Outcomes

Ashley Kim[1], Aron Elias[2], Jalyn Huang[3#]

[1] Leonia High School
[2] Texas Academy of Mathematics and Science
[3] Irvine High School
[#] Advisor

Abstract

Synaptic pruning is a developmental process that eliminates weaker synapses while strengthening essential connections, optimizing brain function across regions such as the hippocampus, sensory cortex, and prefrontal cortex (Rowden, 2023; Faust et al., 2021; Hathaway & Newton, 2023). This process is shaped by both experience-expectant inputs, like vision and hearing, and experience-dependent events unique to each individual (From Neurons to Neighborhoods, 2000). Disruptions caused by early-life stressors, including neglect, poverty, and violence, alter microglial activity and complement protein regulation, resulting in either excessive or impaired pruning and distinct patterns of connectivity (Teicher & Samson, 2016; Zhang et al., 2024). Molecular mechanisms such as microglial engulfment, complement cascades, and dopamine signaling are essential in maintaining pruning balance, and errors in proteins like C4 and Drd2 have been linked to schizophrenia, autism, and anxiety (Sheridan et al., 2022; Zhang et al., 2023; Ju et al., 2017). Current research highlights therapeutic strategies, including complement inhibition, gene editing, and anti-inflammatory treatments, though these approaches must address ethical and developmental challenges to preserve normal brain maturation (Mansur et al., 2021; Dayananda et al., 2022). Together, these findings underscore the complexity of synaptic pruning and its central role in cognition, emotion, and the emergence of psychiatric disorders.

Introduction

Adolescence is a crucial period of brain development and neuroplasticity. During early life, the brain overproduces neurons and synapses, ensuring that any potential connection can be formed (Spear, 2013; Cafasso, 2018). But keeping so many synapses active uses a lot of energy, and as the brain matures, this becomes less efficient (Spear, 2013). To remain functional, the brain must reorganize itself—strengthening the connections that are most useful while trimming back those that are weaker or unnecessary.

This process, known as synaptic pruning, works like cutting back branches on a tree: by removing weaker parts, the stronger branches can thrive. Pruning is most active between ages 2 and 16, but it continues into the 20s as the brain prepares for full maturity (“Advances in Immunology”, 2021; Cafasso, 2018; Zhang et al., 2021). It occurs across many brain regions, including the visual cortex (vision), the hippocampus (memory), and especially the prefrontal cortex, which is critical for decision-making, impulse control, and higher-level thinking (Cafasso, 2018). The timing of pruning is not identical for everyone: for example, females tend to reach peak synaptic density earlier than males, leading to earlier pruning and potentially contributing to differences in cognitive and emotional development (Kirkland et al., 2025; Lepeta et al., 2016).

Pruning does not happen at random. It is shaped by both biology and experience. Synapses that are used most often become stronger, while those that are rarely activated are tagged for elimination (Dayananda et al., 2023; Zhang et al., 2021). At the cellular level, this process is guided by microglia, immune cells that act like the brain’s

janitors by removing weak or unnecessary synapses (Mordelt & Witte, 2023). Microglia rely on proteins in the complement system that function like “labels,” marking certain synapses for removal (Sheridan et al., 2022). Other molecular pathways, such as dopamine and its receptor Drd2, also help regulate pruning in regions like the anterior cingulate cortex, which is involved in emotion and decision-making (Zhang et al., 2021).

Because pruning depends on experience, no two brains develop in exactly the same way. Every day learning, social interaction, and environmental stress all help determine which synapses are kept and which are cut. Early-life stressors—such as neglect, maltreatment, poverty, or exposure to violence—can be especially harmful, since they interfere with the normal balance of pruning during this sensitive developmental period (Teicher & Samson, 2016; White & Kaffman, 2019). By changing which connections are strengthened or eliminated, these experiences can shape long-term differences in brain connectivity and behavior.

When pruning works properly, it creates a leaner, more efficient brain that is ready for adulthood. But when the process is disrupted—through genetic variation, overactive or underactive proteins, or stressful environments—the consequences can be severe. Overpruning (too many synapses removed) and underpruning (too many weak synapses kept) are both linked to psychiatric disorders, including schizophrenia, autism, and anxiety (Zhang et al., 2021; Sheridan et al., 2022). These conditions highlight how important pruning is for normal development, and why researchers continue to study its mechanisms closely.

Definition and Timing of Synaptic Pruning

Synaptic pruning is the brain’s way of trimming away weak connections (Rowden, 2023). It allows the brain to operate most efficiently, which occurs in regions such as the hippocampus, the sensory cortex, and the prefrontal cortex (Rowden, 2023; Faust et al., 2021). Synapses in the brain that are less active will be eliminated through pruning, while those used most actively are retained and reinforced (Faust et al., 2021). In simple terms, the brain strengthens the connections it uses and cuts back the ones it does not. To elaborate further, stronger excitatory synapses, as in neurons most likely to convey information between each other, are left intact, while weaker excitatory synapses have a higher chance of being eliminated (Gonzalez-Burgos et al., 2023; Kornau, 2009). As infants, the brain will overproduce neurons and synaptic connections to compensate for any potential or essential connections in the early life stage (Spear, 2013; Cafasso, 2018). However, this soon becomes too energy-consuming; As we mature into our adolescent stage, the need for overproducing synapses becomes both less demanding and efficient. (Spear, 2013). Synaptic pruning is then able to come into play, keeping only the strongest connections for the most efficient brain functionality (Spear, 2013; Faust et al., 2021). Between the ages of 2 and 16, or from early childhood to adolescence, synaptic pruning is most prevalent, preparing the brain for full maturation by age 25 (“Advances in Immunology”, 2021; Cafasso, 2018; Zhang et al., 2021). This explains why children’s brains are very flexible, while young adults’ brains are more specialized. However, some pruning may persist into the late 20s. For example, the prefrontal cortex—associated with decision-making, cognitive control, social cognition, and personality—often occurs even after the brain has fully matured (Hathaway & Newton, 2023; Faust et al., 2021). Synaptic pruning in the sensory cortex, the area for all cortical functions such as visual, auditory, and somatosensory, and the hippocampus, which is utilized in memory formation, occurs in earlier adolescence (Ashby, 2001; Cleveland Clinic, 2024; Faus et al., 2021). Specifically, pruning in the hippocampus typically occurs around the postnatal period, while pruning in the visual cortex peaks in infancy and early adolescence (Faust et al., 2021). Furthermore, synaptic pruning may differ between females and males: As adolescents, females tend to peak earlier in synaptic density, or the number of synapses, they have (Kirkland et al., 2025; Lepeta et al., 2016). This leads to earlier synaptic pruning, likely contributing to differences in behavior such as the timing of cognitive and emotional development (Kirkland et al., 2025). The process of synaptic pruning is more nuanced than it may initially appear: Various factors—including protein components, specific cells, and, more broadly, an individual's life experiences—influence how the brain stores information.

Experience and Environmental Influences on Pruning

There are two different ways in which the brain is shaped by experience: experience-expectant and experience-dependent development (From Neurons to Neighborhoods: The Science of Early Childhood Development, 2000). There isn't just one kind of pruning—scientists divide it into two main categories. Experience-expectant development utilizes common, expected experiences within all individuals for crucial brain development, whereas experience-dependent development relies on unique, individual experiences in life that contribute to further growth. (From Neurons to Neighborhoods: The Science of Early Childhood Development, 2000). These experiences are what create the strengthening and weakening of synapses, which play a crucial role in synaptic pruning (From Neurons to Neighborhoods: The Science of Early Childhood Development, 2000). Experience-expectant development typically occurs in the neural pathways in postnatal development and relates to the common inputs, such as the visual and auditory systems. Proteins such as C1q and C3 act like 'tags' that mark unused connections for removal. They can be thought of as proteins being sticky notes telling microglia which synapses to clear out. This basic input becomes a typical process within development that unfolds in a similar pattern across all individuals. However, once these basic experiences are deprived or stressed, the regulation of complement proteins can either be overactivated or underactivated, which affects proper development. Experience-dependent development and pruning are not based on universal experiences; Each caters to one's specific experience in early life, meaning that the impacts of impaired synaptic pruning can not be generalized into one behavior, since different types of stress and deprivation will affect the brain in different ways. Furthermore, the different complement proteins (C4, C1q, C3, etc.) that affect parts of the brain in creating synapses will ultimately result in various behavioral outcomes when these proteins are deregulated, demonstrating that experience-dependent pruning is not specified into one outcome (Averbeck, 2022). In a study testing the different types of adversities on mice, Dayananda et al. found that between mice that experienced limited bedding (LB) and unpredictable maternal separation (UPS), those that experienced LB had microglia, an immune cell that helps to eliminate synapses, that were unable to monitor synapses compared to the healthy microglia in the hippocampus. However, those with UPS caused excessive activation in genes related to pruning, which contributed to higher synaptic elimination. Mice with LB experienced more severe impairments in comparison to those with UPS, confirming that different experiences within individuals lead to different impairments of synaptic pruning. In short, different kinds of stress changed pruning in different ways, showing that environment shapes the brain in more than one pattern.

Experience-dependent pruning can stem from various ways. For instance, a group of adversities, also known as ELS (Early Life Stress), can severely impact synaptic pruning in the hippocampal area of the brain (Zhang et al., 2024). These are known as childhood neglect, maltreatment, poverty, systemic racism, and exposure to violence and crime (Teicher & Samson, 2016; White & Kaffman, 2019). These adversities often induce fear within young children, ultimately leading to the activation of glutamatergic neurons—neurons containing glutamate, increasing the neuron's potential of firing (Zhang et al., 2024). This creates a stronger synapse, making it unable to be eliminated in pruning (Zhang et al., 2024). Furthermore, TREM2, an immune protein receptor, was increased in production, which enhanced microglial pruning activity (Zhang et al., 2024). This further eliminates weaker synapses compared to those induced by fear (Zhang et al., 2024). When a majority of fear-induced synapses remain in the brain as an adolescent, it would, in turn, impair the developed brain in comparison to those that do not experience fear-induced adversities (Zhang et al., 2024). These differences in synaptic retention and elimination ultimately lead to individualized patterns of brain connectivity, which are shaped uniquely by each person's own early experiences (Zhang et al., 2024).

When these impairments occur in an individual, they most often result in behavioral dysfunctions, including executive function, emotional regulation, social cognition, and/or memory (Zhang et al., 2024). In the example of fear and synaptic pruning, the increase of fear-induced synapses usually occurs in the prelimbic cortex, utilized for cognitive and emotional regulation (Andero et al., 2014; Zhang et al., 2024). These individuals will have a heightened sense of fear from this learned behavior, which is also known as Pavlovian fear conditioning, contributing to different behavior outcomes (Zhang et al., 2024). Fear would contribute to one's planning and decision-making, ability to regulate emotion, the ability to interact with society, and memory due to the trauma inflicted upon their brain (Zhang et al., 2024). For example, fear is a cause of phobias in individuals; It is embedded

in one's memory, affecting the overall behavior (Johnson, 2024). This would lean into the possibility of developing psychological disorders such as PTSD. As mentioned previously, these environments could be a contributing factor to ELS that adolescents face, impacting synaptic pruning. Overall, when specific experiences affect individuals as adolescents, where synaptic pruning is a significant part of development, it permanently impacts the wrong synapses, impairing behavior even as that individual matures into an adult.

Cellular and Molecular Mechanisms of Pruning

The synaptic pruning process is vast: Consisting of various genes, cells, and proteins that regulate pruning in multiple specific parts of the brain, it is difficult to list every single molecular component of this process. However, one crucial component is the microglia, lying in various areas of the brain, an immune cell in the central nervous system (Mordelt & Witte, 2023; Faust et al., 2022). Microglia—immune cells that act like the brain's janitors— "eat up" weak synapses. (Paolicelli et al., 2011; Deshpande & Wadhwa, 2023). Without microglia, the cleanup crew, pruning couldn't happen. Clearly, the microglia's function is crucial for synaptic pruning; Since the synaptic pruning process's function is to remove unneeded synapses, microglia cells are necessary in the physical process of breaking down the synapses.

Along with microglia, protein complements also take place as mediators in synaptic pruning. Typically, these receptor proteins will tag specific synapses—those that are weakened—so that microglia can identify which synapses it needs to engulf to complete the pruning process (Gomez-Arboledas et al., 2021). One type of use for the complement proteins is the microglial complement signaling cascade, which notifies microglia to engulf a specific synapse (Faust et al., 2022). Neurons send out 'find-me' signals to attract microglia, then 'eat-me' signals to mark weak synapses for removal (Huo et al., 2023). This system works like a tag-and-destroy mission: weak synapses are flagged, and microglia finish the job. The "find-me" signals begin this engulfing process, which includes molecules such as CX3CL1, ATP, glutamate, GABA, dopamine, and norepinephrine that neurons discrete to attract microglial cells to sense the weakened synapses within their surroundings (Huo et al., 2023; Wang et al., 2023). By this time, the low synaptic activity has already been identified by molecules called the "eat-me signals that tag the neurons, such as C1q (Faust et al., 2023; Huo et al., 2023). With C1q on the neurons, other complement protein factors, such as C4 and C2, are activated to start the chain reaction (Faust et al., 2023; Huo et al., 2023). Then, protein C3 in turn will be activated so that CR3, a receptor on microglia, will direct the microglia to specifically identify these proteins to engulf the neurons (Faust et al., 2023). There are various other complement cascade processes, in addition to C1q, C4, C2, and C3.

If this system gets out of balance, pruning can go very wrong; For example, if a version of the C4 gene, the C4A isotope, increases in its expression, it can make an individual more susceptible to schizophrenia (Sheridan et al., 2023). Another example is through protein PS, which attaches to each weakened neuron in the synapse. (Huo et al., 2023). This allows GPR56, a G protein-coupled receptor in the microglia, to signal the microglia to engulf the synapse. Another mechanism of synaptic pruning is with the role of dopamine and its receptor protein Drd2. Specifically in the ACC (anterior cingulate cortex)—which is involved in emotion, anxiety, and decision making—the Drd2 receptor protein is vital in pruning (Zhang et al., 2021). The difference in the amount of Drd2 and its neuronal activity with dopamine in ACC greatly influences overpruning and underpruning synapses, which in turn influences behavior. For example, in a study involving dopamine and Drd2 in mice, the lessening of the Drd2 protein resulted in anxiety-like behaviors (Zhang et al., 2021). All these molecular mechanisms must maintain an efficient balance for synaptic pruning to occur properly; when errors in this system begin, such as overexpression or underexpression of certain genes, that is when dysfunction occurs, which in turn affects behavior. Pruning relies on a careful balance of many signals. If that balance tips, brain function can suffer.

Abnormal Pruning and Links to Psychiatric Disorders

As expressed, pruning is an extremely complex system that includes a variety of components that make it work. When the process goes wrong, the results can be serious. Therefore, if a certain component of a specific process of synaptic pruning were to have an error, the individual would be susceptible to various disorders of the brain. One specific example of this is the development of schizophrenia in individuals. When analyzing brain autopsies, there was sufficient evidence of fewer synaptic connections, specifically in the hippocampus, which is crucial for memory, and the cerebral cortex, which is important for reasoning, thought, and consciousness (Cleveland Clinic, 2024; Sheridan et al., 2022). Because the human cerebral cortex goes through significant synaptic pruning from late adolescence to adulthood, the lack of synapses in this area demonstrates that synapses were lost during this process (Sheridan et al., 2022). Furthermore, in MRI studies, patients with schizophrenia show thinning in the cortex and smaller cortical structures such as the hippocampus, which further proves the effects of overpruning (Sheridan et al., 2022). When schizophrenia begins to show symptoms, they usually occur between the ages of 16 to 25 years old, supporting the timing of too much synaptic pruning in this area (Sheridan et al., 2022). This “overpruning” occurs because of the microglia excessively engulfing synapses in areas like the cerebral cortex and hippocampus (Sheridan et al., 2022). Too much pruning strips away important connections, which can lead to thinking and memory problems, as seen in schizophrenia. Going back to the complement signaling cascade mentioned in section 3, the C4/C4A gene variation can increase the expression of C4A protein in the brain. (Sheridan et al., 2022). This, in turn, would activate the C3 protein and tag more synapses, signaling to the microglia to engulf more synapses (Faust et al., 2023; Sheridan et al., 2023). Overprunning correlates with the cortical thinning of the brain, leading to a deficiency in cognition, thinking, and an increase in psychosis—all symptoms that correlate with schizophrenia (Sheridan et al., 2022).

On the contrary, “underpruning” synapses also poses a problem for individuals. Drd2, or dopamine D2 receptor, is a receptor that responds to dopamine in the prefrontal cortex and anterior cingulate cortex (ACC) (National Library of Medicine, 2025). This is what helps regulate brain development, mood, motivation, and synaptic pruning (Zhang et al., 2023). When certain conditions occur in which Drd2 is reduced, this in turn activates the AKT-mTOR signaling pathway, promoting the decrease of synapse elimination, more than usual (Zhang et al., 2023). Therefore, the synapses that normally should be removed in the brain are kept due to this underpruning, leaving a significant abundance of weakened synapses (Zhang et al., 2023). In turn, the brain becomes incredibly disorganized and inefficient (Zhang et al., 2023). This hyperconnectivity in synapses is correlated with some types of autism spectrum disorder (ASD) and anxiety-like behaviors. Since the excess synapses are unable to be engulfed, the brain is receiving and processing so much information for any stable connectivity, leading to overstimulation, such as in ASD or anxiety (Zhang et. al., 2023; Ju et al., 2017). When adolescents experience either insufficient or excessive synaptic pruning, their mature brain will suffer the consequences. Because certain parts of their brain were impaired, these individuals face a higher chance of facing psychiatric disorders with the neural connections that are kept. As mentioned previously, mood, memory, reasoning, and thought are some of the areas of behavior that are susceptible to damage in adulthood (Zhang et al., 2023; Sheridan et al., 2022). Too little pruning overwhelms the brain with weak connections, leading to overstimulation, as it is typically seen in autism and anxiety (Zhang et al., 2023; Sheridan et al., 2022).

Therapeutic Approaches and Future Directions

Recent research into regulating microglial activity has increasingly focused on strategies to normalize their synaptic pruning functions. For example, Mansur et al. (2021) demonstrated that iPSC-derived astrocytes from individuals with autism secrete significantly lower levels of complement C4, implicating blocking or adjusting complement proteins, such as C4 inhibitors, as a potential intervention to prevent maladaptive synapse removal (Mansur et al., 2021). Together, Dayananda et al. (2022) showed that early-life stress paradigms reduce microglial TREM2 expression and phagocytic function, resulting in excess dendritic spine density—underscoring the potential benefit of anti-inflammatory treatments to stabilize microglial behavior (Dayananda et al., 2022). Another article further supports these ideas by illustrating that impaired microglial synaptic refinement mediated by complement and

TREM2 pathways may underlie synaptopathies observed following early stress, reinforcing the rationale for both complement modulation and anti‑inflammatory approaches (Eltokhi, 2020). Scientists are even testing CRISPR gene-editing tools to change how microglia prune. In other words, researchers are starting to look for ways to directly ‘edit’ how pruning works. This represents a promising avenue for CRISPR or gene therapies to alter the expression of risk genes, such as TREM2 or complement receptors (Dräger et al., 2022).

Despite the therapeutic potential of complement inhibition, gene editing, and anti-inflammatory regimens, all such strategies must carefully address major ethical and developmental challenges. Since synaptic pruning and growth must remain in balance throughout development, excessive dampening of microglial activity or complement function could disrupt normal circuit formation and connectivity (Dayananda et al., 2022; Mansur et al., 2021). Any therapy has to keep pruning in balance—too much or too little can disrupt normal brain growth.

Conclusion

Synaptic pruning is a critical developmental process that sculpts the brain by eliminating weaker synapses while strengthening those most essential for cognition and behavior. Occurring most prominently from childhood through adolescence in regions such as the hippocampus, sensory cortex, and prefrontal cortex, pruning ensures efficient brain functionality by early adulthood (Rowden, 2023; Faust et al., 2021; Hathaway & Newton, 2023). While its timing and intensity vary across brain regions and between males and females, pruning is universally vital for preparing the brain for mature thought, memory, and decision-making (Kirkland et al., 2025; Lepeta et al., 2016).

Experiences strongly influence pruning outcomes. Experience-expectant pruning, shaped by universal sensory inputs, and experience-dependent pruning, shaped by individual life events, both determine which synapses are retained or removed (From Neurons to Neighborhoods, 2000). Stress and adversity, particularly early-life stress such as maltreatment, neglect, or poverty, disrupt these pathways, leading to maladaptive pruning and behavioral consequences (Teicher & Samson, 2016; White & Kaffman, 2019; Zhang et al., 2024). As studies demonstrate, different stressors can produce distinct effects—from excessive synaptic elimination to impaired pruning—highlighting the individualized nature of pruning outcomes (Dayananda et al., 2022).

At the molecular level, microglia and complement proteins play indispensable roles in mediating pruning, guided by intricate cascades of “find-me” and “eat-me” signals (Huo et al., 2023; Faust et al., 2023). However, this complexity also creates vulnerabilities: overactivation of complement pathways, such as C4A, contributes to overpruning linked to schizophrenia, while impaired Drd2 signaling may underlie underpruning seen in autism and anxiety (Sheridan et al., 2022; Zhang et al., 2023). These findings emphasize that maintaining balance in pruning mechanisms is essential for healthy development, as both excess and insufficient pruning lead to long-term psychiatric risks.

References

Andero, R., Choi, D. C., & Ressler, K. J. (2014). Molecular Basis of Memory. *Progress in Molecular Biology and Translational Science*, *122*, 169-192. https://doi.org/10.1016/B978-0-12-420170-5.00006-4

Dayananda, K., Ahmed, S., & Wang, D. (n.d.). Early life stress impairs synaptic pruning in the developing hippocampus. *Brain Behavior*, *107*, 16–31. 10.1016/j.bbi.2022.09.014

Deshpande, O. A., & Wadhwa, R. (2023). Phagocytosis. *StatPearls [Internet]*. https://www.ncbi.nlm.nih.gov/books/NBK556043/

Ebrahimi, M., Teymouri, K., & Chen, C. (2024). Association study of the complement component C4 gene and suicide risk in schizophrenia. *Schizophrenia (Heidelberg)*, *10*(1), 14. https://www.nature.com/articles/s41537-024-00440-w#:~:text=The%20complement%20component%20C4%20gene%2C%20an%20immune%20gene%20involved%20in,strongly%20associated%20with%20schizophrenia%20risk

Faust, T., Gunner, G., & Schafer, D. P. (2021, November). Mechanisms governing activity-dependent synaptic pruning in the mammalian CNS. *Nature Reviews Neuroscience*, *22*(11), 657–673. 10.1038/s41583-021-00507-y

F.G., A. (2001). Categorization and Similarity Models: Neuroscience Applications. *ScienceDirect*, 1535-1538. https://doi.org/10.1016/B0-08-043076-7/00623-9

Gonzalez-Burgos, G., Miyamae, T., Nishihata, Y., Krimer, O. L., & Lewis, D. A. (2024, August 15). Strength of excitatory inputs to layer 3 pyramidal neurons during synaptic pruning in the monkey prefrontal cortex: Relevance for the pathogenesis of schizophrenia. *Biology Psychiatry*, *94*(4), 288-296. 10.1016/j.biopsych.2023.01.019

H.-C, K. (2009). Postsynaptic Density/Architecture at Excitatory Synapses. *Encyclopedia of Neuroscience*, 809-815. https://doi.org/10.1016/B978-008045046-9.01227-4

Hippocampus: What It Is, Function, Location & Damage. (2024, May 14). Cleveland Clinic. Retrieved September 15, 2025, from https://my.clevelandclinic.org/health/body/hippocampus

Johnson, J. (2024, June 26). Effect of emotions on learning, memory, and disorders associated with the changes in expression levels: A narrative review. *Brain Circulation*, *10*(2), 134-144. 10.4103/bc.bc_86_23

Kirkland, J. M., Edgar, E. L., Patel, I., Feustel, P., Belin, S., & Kopec, A. M. (2024, April). Synaptic pruning during adolescence shapes adult social behavior in both males and females. *Developmental Psychobiology*, *66*(3), e22473. 10.1002/dev.22473

Lee, S. W. (2023, July 26). *What is synaptic pruning?* Medical News Today. Retrieved September 15, 2025, from https://www.medicalnewstoday.com/articles/synaptic-pruning#definition

Lepeta, K., Lourenco, M. V., Schweitzer, B. C., Martino Adami, P. V., & Banerjee, P. (2016, September). Synaptopathies: synaptic dysfunction in neurological disorders – A review from students to students. *Journal of Neurochemistry*, *138*(6), 785–805. 10.1111/jnc.13713

Mordelt, A., & Witte, L. (2023, April). Microglia-mediated synaptic pruning as a key deficit in neurodevelopmental disorders: Hype or hope? *Current Opinion in Neurobiology*, *79*. https://doi.org/10.1016/j.conb.2022.102674

National Research Council (U.S.). Committee on Integrating the Science of Early Childhood Development. (2000). *From Neurons to Neighborhoods: The Science of Early Childhood Development* (J. P. Shonkoff, D. Phillips, & D. A. Phillips, Eds.). National Academies Press.

Paolicelli, R. C., Bolasco, G., Pagani, F., & Laura Maggi. (2011, September 9). Synaptic pruning by microglia is necessary for normal brain development. *Science*, *333*(6048), 1456-1458. https://www.science.org/doi/10.1126/science.1202529

Zhang, Y.-Q., Lin, W.-P., & Huang, L.-P. (2021). Early life stress impairs synaptic pruning in the developing hippocampus. *Brain Behavior*, *12*. 10.1016/j.bbi.2022.09.014