Teaching Detained Juveniles About Their Brains: A Study on a Novel Brain-Health Intervention at the St. Joseph County Juvenile Justice Center

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Abstract

The effectiveness of adolescent interventions has been previously demonstrated. The success of such interventions is possibly due to the special ability of the adolescent brain to adapt to new information in his or her environment. Adolescent interventions may be used to change the mindset or beliefs of an adolescent. This paper presents a novel method for an adolescent brain-health intervention aimed at changing a set of beliefs surrounding autonomy over brain development and behavior. This study took place at the St. Joseph County Juvenile Justice Center, where predominantly low-income juveniles are detained. Finding an answer to decreasing the amount of low-income youth that are incarcerated is of major public health and economic implications. The efficacy of the intervention was determined using a 31-question scale that was administered before and after the intervention. Results indicate the intervention was unsuccessful.

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There are 14 million children in the United States, or approximately 18%, living below the federal poverty line (Semega, Fontenot, & Kollar, 2017). Children are constantly learning and growing, which is an adaptive trait under normal circumstances. Unfortunately, the mechanisms underlying children's adaptation to the environment also permit children to adapt to the stress of poverty (Farah, 2017)(McEwen & Gianaros, 2010). For children, living in poverty leads to poor academic achievement, poor emotional regulation, impaired prosocial attributes, and lower resiliency to adverse situations (Yoshikawa, Aber, & Beardslee, 2012)(Brooks-Gunn & Duncan, 1997). Due to these effects, the immense number of children living in poverty is a major public health concern in the United States (Dawson, Ashman, & Carver, 2000). The innate instability of poverty increases stress in all aspects of the child's life (Lee & Jackson, 2017). Just as behavior adapts to the cognitive load of poverty, so does the brain. While growing up, the brain is not immune to the deleterious effects of poverty on the brain (Lee & Jackson, 2017)(Luby et. al, 2013)(Hair, Hanson, Wolfe, & Pollak, 2015). Poverty and its intense cognitive load are associated with smaller white and cortical gray matter and hippocampal and amygdala volumes in children (Luby et. al, 2013)(Noble, Houston, Kan, & Sowell, 2012).

The deleterious effects on the brain may be reversed, or at least slowed, by interventions during childhood. Interventions to mediate the effects of poverty on the developing brain of children are important to study (Hackman, Gallop, Evans, & Farah, 2015)(Farah, 2017)(Blair & Raver, 2016). Successful child interventions thus far have mostly aimed at safe sex, drug, and alcohol use (Office of the Surgeon General, 2001)(Kumar, O'Malley, Johnson, Laetz, 2013)(Armitage & Talibudeen, 2010). Other interventions have also aimed at improving academic performance. One such study involves teaching children to have a growth-mindset, in which children believe that intelligence is not “fixed” and can be fostered and cultivated, as opposed to a fixed-mindset, in which children believe that one is born with a certain amount of unchangeable intelligence (Claro, Paunesku, & Dweck, 2016). In Claro, Paunesku, and Dweck’s study, children with lower academic performance benefited more from the growth-mindset intervention than those with higher academic performance (Claro, Paunesku, & Dweck, 2016). The researchers hypothesized this was because the higher-performing children won’t necessarily use the skills taught in the intervention until necessary (Claro, Paunesku, & Dweck, 2016). Those with higher academic performance haven’t yet been truly challenged in school, or might already have a growth mind-set, so the intervention was ineffective on those children (Claro, Paunesku, & Dweck, 2016). Thus, the knowledge gap between low and high-performing students was lessened by this intervention.

One reason these interventions have been successful in children is because of the plasticity, or adaptability, of the brain offered at the onset of puberty, allotting the perfect opportunity for learning and growth (Piccolo et. al, 2016)(Fuhrmann, Knoll, & Blakemore, 2015). Around the onset of puberty, major changes in the wiring of the brain occur. There is widespread structural and functional brain development in the brain during puberty referred to as the adolescent “window of opportunity” (Fuhrmann, Knoll, & Blakemore, 2015). During this time period, the brains of children from low-income households tend to adapt to the stress of poverty, resulting in adverse behavioral, social, and academic attributes (Fuhrmann, Knoll, & Blakemore, 2015) (McEwen & Gianaros, 2010).

Adult and child interventions, such as a growth-mindset intervention to increase academic performance, typically aim to adjust the attitude or set of beliefs of a particular set of people in order to obtain a desired outcome. This study aims to adjust a set of beliefs surrounding brain development and plasticity in detained minors in order to increase their perceived autonomy over their behavior and their future. Specifically, this study was done at the St. Joseph Juvenile Justice Center and consisted of a 4, 30-minute lesson courses on anatomy of the brain, neural plasticity, emotional regulation, and the brain-behavior cyclical connection.

The reason this study chose to recruit participants at the St. Joseph Juvenile Justice Center is due to the typical attributes of detained juveniles. Detained juveniles tend to live in a high-stress home environment that, as explained previously, is associated with deleterious effects on the brain (Lee & Jackson, 2017)(Luby et. al, 2013)(Hair, Hanson, Wolfe, & Pollak, 2015). The high-stress home environment that juvenile detainees often belong consist mostly of low-income minorities (African American or White/Hispanic) with high Adverse Childhood Experiences scores (ACE scores) (Perez, Jennings, Baglivio, 2018). ACE is a scale that determines that number of adverse childhood experiences a person has experienced, such as emotional or physical abuse, mental illness in the household, and substance abuse in the household (Felitti et. al, 1998). High ACE scores are associated with a wide variety of outcomes as an adult, such as higher rates of mental and physical illness, lower rates of educational attainment, and higher rates of poverty (Felitti et. al, 1998)(Bethell, Newacheck, Hawes, & Halfon, 2014)(Childhood and Adolescent Health Measurement Initiative, 2013) .

Results of this study were determined using a 31-statement scale in order to test specific beliefs that changed over the 4-lesson course. This study predicts that in general, scores on the scale will indicate an overall increase in a healthy-brain mindset. Those with higher ACE scores and lower average incomes, indicating a high stress home environment, will have a greater change in beliefs according to the scale. This hypothesis is based on the results from the growth-mindset intervention done in middle schools by Claro, Paunesku, and Dweck in 2016. Results indicate that the hypothesis wasn't proven, likely due to the small sample size and difficulty with juvenile cooperation. Results indicate that a high score differential between pre- and post-intervention scores was best predicted by the number of previous detainments. Brain-health interventions in detained minors must continue to be studied in order to confirm these results.

Methods

Participants

The participants included 7 children between 14 and 19 years of age. All 7 participants were male. Four of the participants were part of an ethnic or racial minority (White/Hispanic or African American), and 3 were not part of an ethnic or racial minority (White/Non-Hispanic). Three children lived in a zip code with a median household income of <$40,000, and 4 lived in a zip code with a median household income between $40,000 and $51,000. Information on ACE score, number of previous detainments, highest offense crime filed against the child, and race/ethnicity were also collected on each child. Children were recruited through the St. Joseph Probate Court where they were all detained during the course of the research study. There were no exclusionary characteristics. If the child was detained for the duration of the course, then he or she could participate in the research study. There was also no randomization process within Juvenile Detention. If the child was competent, and appropriate assent was obtained, then the child could participate. The researcher took steps to obtain parental permission in person, by phone, or by an appointed Guardian Ad Litem when applicable. If the parent could not practicably be contacted, parental permission was waived. Each participating child provided assent to participate in the research study.

Scale

The scale was developed by the researcher in conjunction with the Center for Social Research at the University of Notre Dame. The scale consisted of 31 statements that the child circled if he/she agreed with the statement (Appendix A). The scale includes one statement to determine the reliability of the scale for each child. If the child failed the validity check, then his or her scale was not used in the conglomerate data. The scale had approximately a 6th grade reading level according to the Flesch-Kincaid Grade Level. The child's data was coded using his or her initials on the scale. The scale was conducted verbally one-on-one with the researcher at the St. Joseph Probate court in Juvenile Detention. The 31 statements can be divided into 4 categories that reflect the 4 sessions within the course: anatomy/function, emotional regulation, neural plasticity, and neuronal development. There are 4 statements on anatomy/function, 7 statements on emotional regulation, 6 statements on neural plasticity, 13 statements on neuronal development, and 1 validity check statement.

The researcher went to the St. Joseph Probate Court on Monday, Wednesday, and Friday (M/W/F) mornings from August, 2017 – January, 2018. The pre-scale was conducted on the M/W/F prior to the start of the course, while the post-scale conducted on the M/W/F immediately following the last session in the course.

Content of the Intervention

The course consisted of 4-20 minute sessions on M/W/F mornings. Each session focused on one specific topic.

The first session focused on anatomy and functions of the brain, specifically the location of the nucleus accumbens (NAcc), the amygdala (AM), and the prefrontal cortex (PFC), and their functions. The session began by playing the song "Dear Mama" by Tupac (Tupac), and the researcher asked how the song made the child feel. This provided an opportunity for the researcher to explain the basic process of perception of music in order to give the children a basic understanding of the function of a neuron. Pictures of the neuron and a map of the brain that showed the NAcc, AM, and PFC were passed around the room (Appendix B) ("Business Man")(Lee)("Waiting for Pleasure, 2015). The session ended with a discussion of the connections between the NAcc, AM, and PFC, and situations in which those connections are highly activated. The researcher then asked the children to talk about something that makes them angry, and then the researcher explained the feeling of anger within the context of the NAcc, AM, and PFC. The main learning goal of this first session was to be able to identify the NAcc, AM, and PFC, and their functional roles.

The second session focused on emotional regulation. The session started by playing the song "I" by Kendrick Lamar, and the researcher re-emphasized the anatomy and function lesson from the first session, again using perception of music as a tool to explain the function of a neuron (Kendrick). The researcher and the children then talked about the physiological aspects of feelings, i.e. increased breathing rate and heart rate in contexts of exercising versus contexts of being searched by the police. The researcher talked how to recognize when you are feeling angry or upset, and how to control acting out on that feeling using the connections among the NAcc, AM, and PFC. The researcher discussed skills and tactics to control anger, such as distracting oneself by counting. The researcher then discussed how utilizing these skills to regulate emotions can change one's life, particularly in the context of being detained. Each child was then asked to utilize these skills prior to the next session, and keep note of the incident in order to share with the group in the next session. Normally, there are conflicts among the children or between staff and children, and the researcher was hoping that in the next conflict, the child would count to ten in his/her head, or start reciting the lyrics to his/her favorite song, instead of acting on his/her emotion. The goal of this second session was to develop the ability to identify which emotion one is feeling, based on physiological clues. The other goal was to identify skills and techniques to shift the control of emotion towards the PFC and away from the amygdala.

The third session focused on neural plasticity. The session began by discussing one incident that occurred since the last class in which the child employed some of the emotional regulation techniques we discussed. The concept of neural plasticity was explained, and then a video was then shown of two neurons making a new connection (Appendix C). The researcher asked the children to think of this video when they are angry or upset, and think about the new connections in the brain that are made when the child makes decisions out of anger versus employing strategies discussed during the lessons. This introduced the idea of a cyclical connection between brain and behavior—when behavior changes, so does the brain, and when the brain changes, behavioral change necessarily follows. The researcher then introduced the idea that each of the child's brains formed in interaction with their environment and neighborhood. The researcher talked about the effect that parents can have on the brain of their child. The researcher then introduced the concept of the "window of opportunity" that adolescents and teens can take advantage of in terms of neural plasticity. The researcher then asked the children to make one emotionally-related goal that would be shared in the next session. Examples include to be nicer to his/her mother, to act out less in school, or to remain calm during the next conflict with a police officer. The goal of this third session was for the children to understand the changing connections in the brain, particularly among the NAcc, AM, and PFC. The children should also understand the concept of neural plasticity and the cyclical brain and behavior connection.

The fourth session focused on neuronal development and having a future-oriented mindset. The first discussion in this session was on the emotionally-related goal that each child made in the previous session. Next, the children discussed the decisions that led to their detainment. The researcher discussed how these decisions change the connections within the brain via the brain-behavior cyclical connection. The researcher emphasized this cyclical connection and the window of opportunity that each child has to form their brain into a brain they want and that they are proud of. The researcher discussed role models, and asked each child to name a role model of theirs in terms of brain development, e.g. a person whose brain the child would like to emulate. The researcher discussed how each child has a choice in their behavior, and therefore a choice in the connections in their brain and who they turn out to be. The researcher then re-emphasized the emotional regulation techniques discussed in the second session, and the shift of emotional regulation away from the AM and towards the PFC. The researcher discussed how employing these techniques may be difficult at first, and the researcher talked about the concept of impulsiveness. The researcher emphasized these new techniques would soon become second-nature as the connections in the child's brain change to accommodate those techniques. The goal of this session was to re-emphasize the three previous lessons, and to establish the idea of being future-oriented and goal-oriented.

Results

The objective of data analysis was to determine if there was any significant difference in scores on the scale before and after a child underwent the intervention. Data analysis also looked at subsets of children by age, race, ACE score, highest offense crime filed, median household income by zip code, and number of previous detainments. Data analysis was done using VassarStats. A paired T-Test was performed for the scores prior to the start of the course and the scores following the end of the course for the whole sample (Figure 1). The difference between the post-score and the pre-score was calculated for each participant. These difference-scores were compared using a paired T-Test in the following situations: under 16 versus over 16, Minority (African American & White/Hispanic versus Non-Minority (White/Non-Hispanic), <5 ACE score versus 5+ ACE score, misdemeanor and level 6 felonies versus federal crimes and level 5 felonies or higher, and <$40,000 median household income and >$40,000 median household income (Figure 2-7). Median household incomes by zip code was determined by the Census Bureau ("American FactFinder").

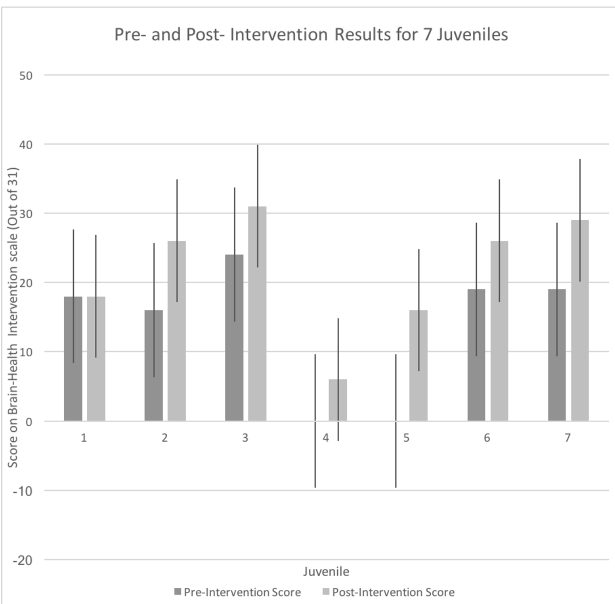

Fig 1. The effect of the intervention for the entire study group. No significant difference (p>0.1) was found between the pre-intervention score and post-intervention score. Error bars indicate +/- 1 standard deviation.

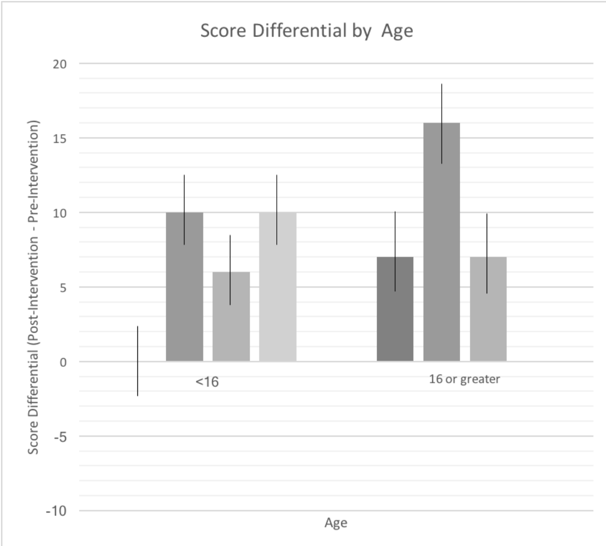

Fig 2. The effect of the intervention by age. No significant difference (p>0.1) was found for those under the age of 16 versus those over the age of 16. Error bars indicate +/- 1 standard deviation.

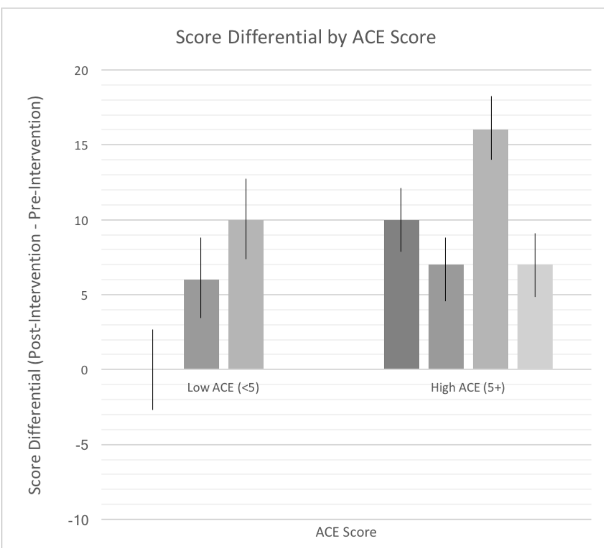

Fig 3. The effect of the intervention by ACE score. No significant difference (p>0.1) was found for those with a lower ACE score (<5) versus those with a higher ACE score (5+). Error bars indicate +/- 1 standard deviation.

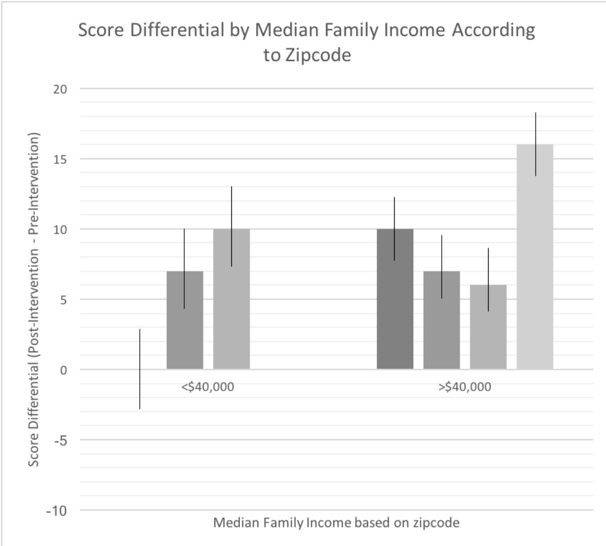

Fig 4. The effect of the intervention by median family income according to zip code. No significant difference (p>0.1) was found for those with a lower median family household income (<$40,000) versus those with a higher median family household income (>$40,000). Error bars indicate +/- 1 standard deviation.

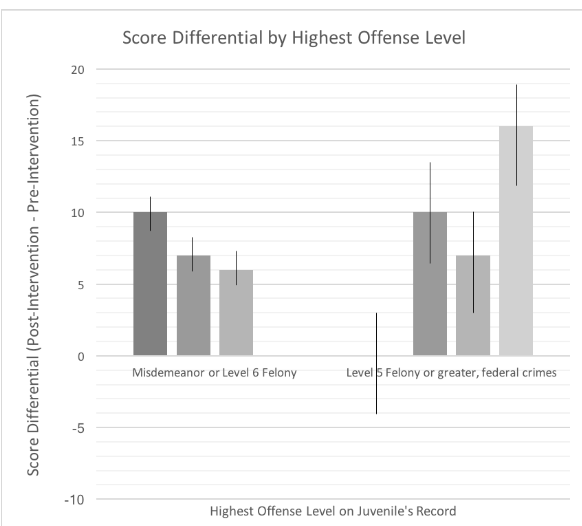

Fig 5. The effect of the intervention by offense level. No significant difference (p>0.1) was found for those with a high offense level (level 5 felony and greater, or a federal crime) versus those with a lower offense level ever filed (misdemeanor or level 6 felony). Error bars indicate +/- 1 standard deviation.

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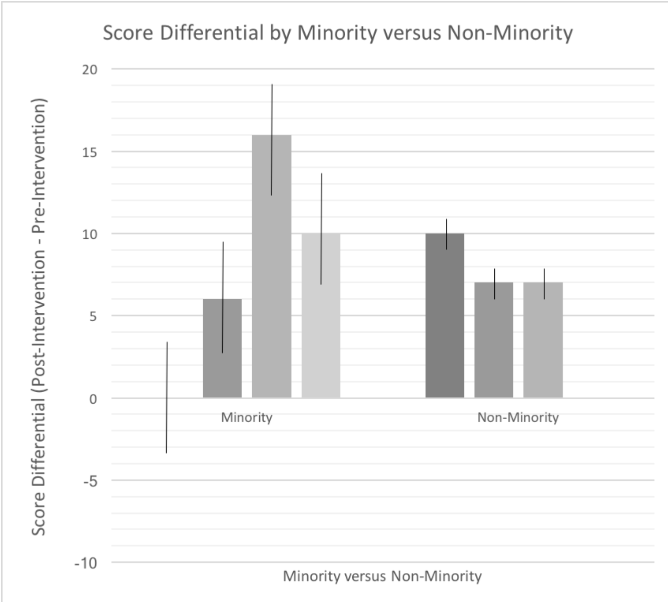

Fig 6. The effect of the intervention by racial/ethnic identity. No significant difference ($p>0.1$) was found for those within a racial/ethnic minority (African American or White/Hispanic) versus those not within a racial/ethnic minority (White/Non-Hispanic). Error bars indicate +/- 1 standard deviation.

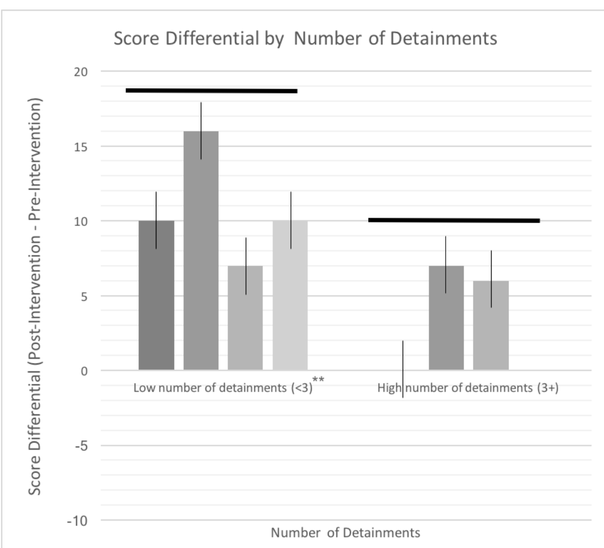

Fig 7. The effect of the intervention by total number of previous detainments. A significant difference ($p<0.1$) was found for those with fewer detainments (<3) versus those with a higher number of detainments (3+). Error bars indicate +/- 1 standard deviation.

Results indicate no significant difference between pre- and post- intervention scores for the whole sample (p=0.132), no significant difference in score differential by age (p=0.394), no significant difference in score differential by ACE score (p=0.313), no significant difference in score differential by median household income (p=0.313), no significant difference in score differential by highest filed offense level (p=0.893), and no significant difference in score differential by race/ethnicity (p=1.00) (Figure 1-6). Results do indicate a significant difference in score differential by total number of previous detainments (p=0.076) (Figure 7).

Discussion

The goal of the present research was to find if a novel brain-health intervention in detained juveniles can change a set of beliefs surrounding autonomy over brain development and behavior. Results indicate the answer is “no.” The small study sample means this data cannot yet be relied upon. The study sample was small for a number of factors: lack of parental cooperation, resulting in a waiver of parental consent, lack of juvenile cooperation, due to a mistrust of any intervention implemented by the justice system, a number of incidents and/or fights among the detainees that resulted in the child being unable to participate for that day, nulling his score, and the lack of juveniles that were detained for the entirety of the programming. At the St. Joseph Juvenile Justice Center, the average length of stay is approximately 24 days. In juvenile justice, the goal of detainment is often to get the child away from household and social violence, and send the child to a treatment center for substance abuse, anger management, or mental illness (Evans-Chase, Kim, & Zhou, 2013). This is another limiting factor in the study—many rehabilitation facilities are now employing neuropsychological techniques. With the rise of knowledge on the adolescent brain, it is becoming more clear that knowledge of neural plasticity and neural development is pertinent to psychosocial and emotional rehabilitation of a juvenile.

There were instances in which the juvenile had already been taught information on the developing brain during previous rehabilitation, which confound the results of the scale.

It is interesting to note the best predictor of a high score differential was based on the number of previous detainments. A lower number of previous detainments indicated a significantly higher score differential. There are a few possible reasons for this. Those with a lower number of previous detainments are likely younger and more adaptable, yet there was no significant difference in score differential by age. The more likely reason is that at the St. Joseph Juvenile Justice Center, there is continuous "programming," or interventions in order to keep the juveniles occupied and give them as much support and information as possible during their short stay. This programming includes exercise, drumming, and other interventions aimed at changing the socioemotional, psychological, and behavioral attributes of the juveniles. Those who have been detained previously may have grown tired of said programming, and simply stopped paying attention or participating during required programming.

Many other interventions with juvenile delinquents have unfortunately been unsuccessful as well. It is hypothesized this is because the first window of opportunity in terms of brain development occurs during infancy, and a high-stress environment during this period of time may have irreversible effects on the brain, despite any attempts during the second window of opportunity during adolescence (Evans-Chase, Kim, & Zhou, 2013)(Fuhrmann, Knoll, & Blakemore, 2015).

Across the United States, there are nearly 100,000 juveniles detained in juvenile justice facilities ("The Costs of Confinement," 2009). Most of these detainees are minorities of low-income backgrounds with high ACE scores (Perez, Jennings, Baglivio, 2018). Intervening during the adolescent "window of opportunity" could lead to changing beliefs on autonomy over one's brain development, behavior and ultimately, future. Implications of this study in the future include an increase in positive prosocial and behavioral attributes, resulting in a decreased recidivism rates in juveniles In addition, the United States spends billions per year incarcerating youth, which is detrimental to the United States economy (“The Costs of Confinement,” 2009). Finding an answer to decreasing the deleterious effects of poverty on the brain of low-income youth and reducing the juvenile recidivism rate is of major public health and economic implications (Perez, Jennings, Baglivio, 2018). Future studies must explore whether adolescent interventions do reverse or slow-down the deleterious effects of high-stress childhood environments, such as low-income environments, by imaging the brains of children. It is necessary for this study to continue in order to collect data from more participants, and thus have more reliable results.

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Appendix

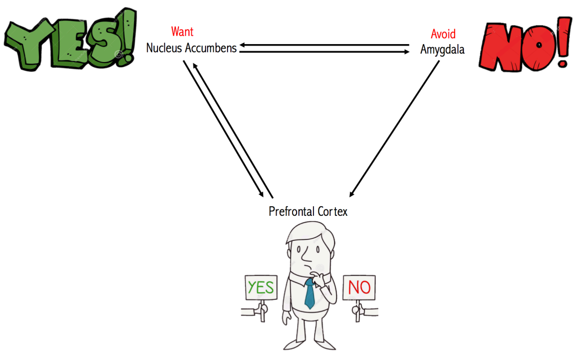
Appendix A: Scale

Instructions: Circle the numbers for sentences you believe to be true.

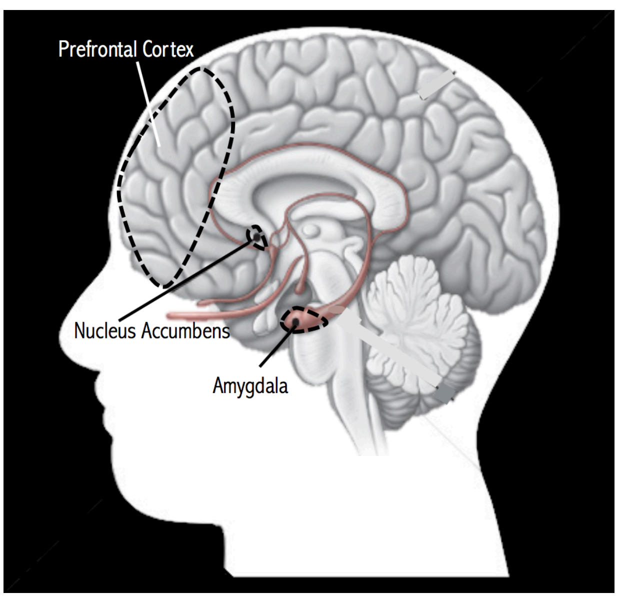
1. I understand what a neuron does.
2. I understand what the nucleus accumbens does.
3. I understand what the prefrontal cortex does.
4. I understand what the amygdala does.
5. I understand the relationship between the amygdala, prefrontal cortex, and nucleus accumens.
6. I understand what the cortical homunculus is.
7. I understand how the brain creates emotions.
8. I know my emotions.
9. Some emotions feel the same. For example, you may feel both excited and nervous before you go on a roller coaster. You can confidently say you are able to distinguish between emotions.
10. I am able to distract myself when I am upset, so that I don't act out my anger.
11. I understand how my emotions now might affect who I grow up to be later.
12. I know what neural plasticity is.
13. The environment in which I grew up shaped my brain.
14. I think my brain changes due to my behavior.
15. I think my brain is constantly changing.
16. Everyone has a different brain.
17. My brain would be different if I grew up in a different setting.
18. I can control my emotions.
19. I can change the connections in my brain.
20. I want strong connections in my brain between the amygdala and the prefrontal cortex.
21. My behavior is determined by the connections that exist in my brain.
22. The decisions I make align with whom I want to be when I grow up.
23. I have control over my future because I have control over my brain.
24. I understand how my brain and behavior led me to the JJC.
25. I can stop myself from acting out by distracting myself when I get upset.
26. I know what type of behavior it takes to do stay out of here.
27. I can choose my behaviors so that I don't come back to the JJC.
28. Every decision I make either strengthens or weakens connections in my brain.
29. If I line up my behavior with the behavior it takes to stay out of here, I will change the connections in my brain. Eventually, this behavior will be easier and I will never come back here.
30. I have control over my brain.
31. I have a choice in the person I grow up to be because I have a choice in the connections in my brain.

Appendix B: Images Used in Lesson on Anatomy and Function

1)



2)



3)

Appendix C: Link to Neural Connections Video

https://www.youtube.com/watch?v=8NA_o1jOjsQ

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