How the ADHD brain matures in comparison to typical development

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Abstract

ADHD most often persists into adulthood. Understanding how the ADHD brain matures differently can help with the best treatments for the individual. This proposal is a first step on the road to understanding how ADHD brains mature and compensate over the lifetime. A resting state fMRI can confirm adult ADHD diagnosis and a qualitative interview can tell us what the experience of those with adult ADHD is in regard to symptomology. This is a first step on the road to understanding health and treatment for those inflicted with this developmental disorder. Write a 150–250 word abstract for your research proposal.

How the ADHD brain matures in comparison to typical development

Attention deficit hyperactivity disorder (ADHD) is a common childhood developmental disorder. When children grow into adults, sometimes the ADHD goes with them. In the UK, as many as 60% of the children diagnosed with ADHD carry that diagnosis into adulthood, many of them without the aid of continuing medication or medical assistance (McCarthy, et al, 2012). As the tools to diagnose this disorder have improved the number of people diagnosed has increased. In the United States the National Survey of Children's Health (NSCH) states that in 2011 11% of the population between the ages of 4 and 17 had been diagnosed with ADHD, representing a 42% increase from the 2003 (National Institutes of Health, n.d.). The way those brains mature and develop past young adulthood is a blind spot in medical literature that prevents us from having good answers for those diagnosed later in life. ADHD brains continue to mature and develop differently from typical development and overall, the medical community has no idea what that maturity looks like and how it differs.

As we age, our bodies continue to change. There is lots of information regarding childhood and adolescence. We know the trajectory of changing brains and there is much research on the ways that ADHD affects children up to young adulthood. However, beyond young adulthood research drops off sharply leaving us in the dark about how brains continue to mature.

Conducting further research can give us insight into the supports that ADHD brains require as they age. Allowing ourselves more understanding and knowledge is the only thing that can break the stigma of a diagnosis label and allow individuals with these developmental differences the ability to be comfortable and functional without limiting their ability to function in society because of a label.

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Literature Review

As our technology has improved, the way we identify neurodivergent brains has changed. ADHD is not an imaginary diagnosis with made up symptoms. There are many new tests that can be used to identify the operation of an ADHD brain and identify physiological differences at every stage of development.

Available Research

Most ADHD studies focus on children and learning deficits that are present with ADHD. Studies that address adult ADHD generally focus on the identity of ADHD post childhood. Of the eight studies utilized for this literature review five of them are longitudinal, two of them are literature reviews in their own right and the final article considered those with substance use issues and how that relates to untreated ADHD in adulthood. All of these articles, in one way or another, look at different ways to identify aspects of ADHD. Some consider different kinds of imaging and others look at assessment tests such as the Stroop color test to determine deficits in comparison to normally developing brains.

Identifying Adult ADHD

One of the things researchers attempted to capture in the studies that were reviewed is the development of an ADHD brain into adulthood without the use of stimulant medication (Bouziane, et al, 2017); Hsiang-Yuan, et al, (2018)). While these studies looked at different things in the medication naïve adults, they both came to a similar conclusion: there are differences between a typically developed brain and a brain dealing with the cognitive differences of ADHD. Bouziane, et al, (2017) looked at the development of white matter in the brains of people who were diagnosed with ADHD as children but remained unmedicated in comparison with those who were typically developing. Their imaging observations showed that there was less white matter in unmedicated adult ADHD patients than in their normally developed counterparts.

Hsiang-Yuan, et al, (2018) went one step further and attempted to identify medication

naïve ADHD adults using resting-state fMRI. They were able to distinguish typically developing brains from those with ADHD by analyzing resting state connectivity. Several of the studies pointed out other options for ADHD predictors in adolescents and young adults using behaviors such as opioid use (Samal, et al, 2022), video games that measure assessment parameters related to attentional processing (Peñuelas-Calvo, et al, 2022) and wearable monitors that record activity data (Kaur & Kahlon, 2022).

Confirming differences between adult ADHD brains and typically developing brains Onandia-Hinchado, et al, (2021) looked at 93 different articles and assessed for differences between typical brains and ADHD brains. This literature analysis looked at five different domains: attention processing speed, executive functioning, learning and memory, social cognition, and arithmetic. Deficits were found in every domain assessed showing that even into adulthood processing remains difficult and those processing difficulties can be assessed and identified.

Longitudinal Studies of ADHD: How we grow

One useful way to study the development of ADHD brains is through longitudinal study. These studies, however, are often expensive and suffer from attrition on every level losing both researchers and participants over time. To combat this attrition, researchers in the UK used an anonymized data base to which general practitioners report patient information. This study uncovered 610 patients with follow-up information that allowed inclusion into a longitudinal study. Of this population, ~40% continued treatment into adulthood while ~60% of this population continued to be symptomatic. The researchers noted that those who continued medication into adulthood were often not monitored past the age of 18 pointing out the troubling lack of data on ADHD in adulthood and how that lack of medication and monitoring might affect functioning (McCarthy, et al, 2012).

McCarthy, et al, (2012) relied on the clinical definition of symptom remission to determine whether ADHD followed a patient into young adulthood or not. Guimarães-da-Silva, et al, (2018) attempted a similar longitudinal study using childhood records to find a population of ADHD adults. These adults were then retested to determine whether they were still experiencing symptoms. An absence of symptomology was equated with remission but when participants were retested it was found that the remitted brains did not match normally developing brains. This suggests that there is no such thing as remission, just a change in symptomology. This confirms the findings of Hsiang-Yuan, et al, (2018), that ADHD brains do not change into normal brains upon entering adulthood.

In 2021 a group of researchers in Norway completed a 10 year longitudinal study that considered the development of executive function among ADHD brains, autism spectrum (ASD) brains, and typically developing brains. This study brought our understanding of that development up to young adulthood. In that development, ADHD brains lagged behind typically developing brains into young adulthood regardless of medication. There is no answer for what happens as the brain continues to develop past the age of 18. These affected brains do not suddenly revert to being the same as their typically developing counterparts (Fossum, et al, 2021). There is no further research on the ways in which atypical brains develop and compensate as they age.

Conclusions and Hypothesis

The body of work concerning the progression of ADHD into adulthood is slowly beginning to expand. Until recently we disregarded the effects of ADHD on the individual beyond childhood. As our ability to diagnose this disorder improves, we are left with more and more individuals struggling with this symptomology. Executive function, including working and short term memory are often detrimentally effected. There are processing biases that create differences in the way ADHD brains process the world in comparison to normally developing

brains (Cohen, & Kalanthroff, 2019). Treatment often does not extend into adulthood even with a confirmed diagnosis (McCarthy, et al, 2012). How those brains continue to develop and change, how the symptomology of those differences affects relationships, jobs, and general functioning in society can push us to provide better care for improved quality of life among this population. Now that we know different ways to diagnose and categorize even those who were not diagnosed as children, the time has come to monitor and understand the continued maturation and development of those atypical brains.

Method

Research Design

How brains develop and mature over time can only really be seen in a longitudinal observation. As discussed previously, these observations are time consuming and can suffer from attrition in both participants and researchers. Therefore, a longitudinal design that starts later in the participant timeline will show us what happens beyond young adulthood, therefore opening the study only to those 18 and over. This design allows us to do between participants comparisons as well as within participant comparisons. Within participant comparison can allow us to bring in minor records for adult participants. This research design also allows for a qualitative element to record the experience of those with ADHD as they age.

Participants

Our population of interest is those with ADHD who are over the age of 18. Because of the difficulty of diagnosing ADHD over the age of 12 our participants should have already been assessed for ADHD or be suspected of having ADHD by a psychological professional (Saleh, et al, 2018). As such, recruitment through the offices of psychological professionals who either specialize in or frequently deal with ADHD adults would be ideal. Those individuals could be anywhere in the country so long as they have a clinic within driving distance where testing and imaging can be administered. This recruitment can occur via pamphlets that explain the specifics of the study, the requirements and inclusion criterion as well as any compensation like

travel reimbursement and/or reward for completion of the study.

Participants with neurocognitive comorbidities, such as, obsessive compulsive disorder, autism spectrum disorder, and the like, will be excluded. The recruitment goal of ADHD individuals is 150 total with no concern for gender. It is expected that the male portion of the cohort will outweigh the female portion. Participants would need to have a diagnosis from the referring physician to qualify for the study.

Measures

This is an observational study to understand the differences between the maturation of a typically developing adult brain versus a brain that is inflicted with ADHD. This study will include a resting state functional magnetic resonance (rs-fMRI) imaging observation and a qualitative interview to record each participant's experience with ADHD. The study will have three sessions, five years apart.

Resting state fMRI is an imaging technique that shows the connectivity in the brain when there is no demand for function. It uses an MRI machine to track electrical impulses in the brain. The qualitative interview can be performed before or after the imaging. This interview is intended to give us an insight into living with ADHD and how that experience changes over time.

Materials and Setting

This study will require access to an fMRI machine for a seven minute resting state scan for each participant. Therefore, this study should take place in the imaging offices where the fMRI is being utilized. The location of the machinery will be based on the local of the participant. Being within driving distance of an imaging facility is a requirement for participation. Qualitative interviews will be provided by researchers at the time of scan. Compensation for time and travel will be provided at the time of imaging.

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Procedures

Participants will be gathered through advertisement of the study to health care providers

who provide care to adult ADHD sufferers. Each potential participant will be screened to determine ADHD diagnosis, exclusionary comorbidities, and location in relation to an imaging facility. Participants will be scheduled for their rs-fMRI. On the day of the imaging appointment, participants will participate in a 15 minute interview with a researcher to answer questions about their experience with executive function. Once the participant is hooked up to the fMRI machine, they will be asked to close their eyes but remain awake for the duration of the scan. At the conclusion of the scan participants will be asked to confirm that they remained awake for the duration of the scan. Participants should then be provided with travel and time compensation of either a standard per mile or reimbursement for gasoline with receipts.

Images acquired through this procedure will then be compared to rs-fMRI images of typical adult brains as acquired through other studies with the cooperation of the psychology department of Duke University big brain studies.

Ethical, Legal, Individual, and Socio-Cultural Considerations

At each encounter with participants, researchers should disclose who they are and the purpose for the interaction. Observational participants shall be informed of the purpose and steps of the study prior to signing any consent forms. Participants will be assigned a number as identification in the study to anonymize the results and protect participant identity as per the APA.

This study does not address sociocultural differences among ADHD sufferers, nor does it address differences in gender. This study is strictly interested in the development of the ADHD brain post young adulthood regardless of gender or poverty level. Future research including other imaging techniques to determine the ways in which the ADHD brain compensates with age are warranted.

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Discussion

ADHD is a developmental disorder. Human development continues form birth until death. However, the development of ADHD has only been studied into young adulthood. Understanding how this disorder develops as people age can help us to develop better treatments for the dysfunction that it causes. This data can also, potentially, show us the ways in which PTSD and ADHD differ in the adult brain. Using this as the basis for further study, PTSD and ADHD can also be compared with the same biomarkers. They can be watched and compared longitudinally giving us a better idea of how the two disorders differ.

If the rs-fMRI proves that ADHD has a consistent biomarker over the course of maturation, this may be a good way to affirm an ADHD diagnosis. There are many people who went undiagnosed over their childhood as we are just now starting to have a decent understanding of the mechanisms of the disorder. Without information on childhood, behavioral self-report is our only tool. Currently PTSD and ADHD in adults is hard to differentiate, (Saleh, et al, 2018), this study may give us a better window into how they differ so that treatment can be tailored to the individual.

Future research could include a longitudinal DTI study of those identified by resting state biomarker to have ADHD to see the ways in which the brain compensates as it matures. We know ADHD does not catch up to typical development up to young adulthood (Guimarães-da-Silva, 2018), but beyond that we have little to no data. If an ADHD brain never catches up in development then what differences are there in function in maturity? We know ADHD brains lack certain biases that seem to be automatic in typical development (Cohen, & Kalanthroff, 2019). We do not know how that might affect future function or if there are other things that seem to be built in to typical development that present differently in the ADHD or not at all. We are just beginning to understand the way ADHD is affected by age. This

knowledge improves treatment and informs the way we transition clients from childhood into adulthood with the necessary supports for their success.

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