The Relationship between Cognitive Insight and Executive Functioning in Attention-Deficit Hyperactivity Disorder

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Abstract

Cognitive insight is a measure of one’s ability to self-reflect and one’s self-certainty, or ability to modify previously held beliefs. Impairment of cognitive insight leads to a poorer outcome in patients, and has been associated with poor compliance to treatment. Previous studies have shown that impaired cognitive insight is prevalent in schizophrenia, and can be attributable to right hemispherical damage and damage to various neural substrates including the prefrontal cortex, anterior cingulate cortex, posterior cingulate cortex, precuneus, and the thalamus. Interestingly, implicated in these brain regions, particularly in the right hemisphere are also characteristic of attentional deficit hyperactivity disorder (ADHD). This study aims to determine whether there is a correlation between cognitive insight and ADHD. The relationship between cognitive insight and executive functioning (affected in both ADHD and schizophrenia) is also examined in this study. This is to determine whether cognitive insight impairment is specific to ADHD, or if it is manifested in a variety of disorders that affect executive functioning.
The Relationship between Cognitive Insight and Executive Functioning in Attention-Deficit Hyperactivity Disorder

Attention-deficit hyperactivity disorder (ADHD) is a neurodevelopmental disorder characterized by behavioral symptoms of hyperactivity, impulsivity, and inattention (Castellanos, Sonuga-Barke, Milham, & Tannock, 2006). Based on these symptoms, psychiatrists have distinguished three subtypes of ADHD: inattentive, hyperactive-impulsive, and combined. The inattentive subtype displays symptoms such as difficulty paying attention and staying focused, being easily distracted, and avoiding tasks that involve effort. The hyperactive-impulsive subtype, on the other hand, involves symptoms of talking out of turn, difficulty playing quietly, and difficulty sitting still. Among these subtypes, the combined subtype is the most prevalent. Overall prevalence of ADHD is fairly high among children, affecting 5-10% school-aged children, and is less prevalent in adults (Di Michele, Prichep, John, & Chabot, 2005). ADHD symptoms often remit as the individual ages; however, symptoms persist into adulthood in 50-60% of the cases (Purper-Ouakil, Ramoz, Lepagnol-Bestel, Gorwood, & Simonneau, 2011).

Despite the high prevalence and the classification of three subtypes, the diagnosis of ADHD remains controversial. Classification and diagnostic criteria has changed several times, thus rendering current definitions inconsistent (Di Michele et al., 2005). This is apparent when comparing diagnostic criteria for ADHD between the DSM-IV and DSM-V. The DSM-IV states hyperactive-impulsive or inattentive symptoms must be present prior to age 7, while the DSM-V requires that several ADHD symptoms be present before the age of 12 (APA, 2013). This inconsistency results in discrepancies in diagnosis, possibly contributing to a misdiagnosis of ADHD. Because of this, more objective, neuropsychological approaches would prove beneficial when dealing with ADHD. Such approaches would allow scientists to develop differential
diagnostic criteria, which would increase the likelihood of correct diagnoses (Di Michele et al., 2005).

In attempt to improve the diagnosis for ADHD, investigators have used Quantitative Electroencephalography (QEEG) and Variable Resolution Electromagnetic Tomography (VERTA) techniques to reveal biological markers in ADHD (Di Michele et al., 2005). QEEG measures neural functioning, and is less expensive and invasive than other functioning neuroimaging techniques such as positron emission tomography (PET) and functional magnetic resonance imaging (fMRI). VARETA then provides a localized MRI representation of the EEG (or QEEG) measures, and is used to discover areas of pathophysiology. These methods reveal that striatal impairment inhibits function of the thalamus, and thus implicates the cortico-striatal-thalamic-cortical circuit. In addition to this circuit, the fronto-striatal system also seems to be implicated in ADHD, which includes the caudate nucleus, prefrontal cortex (PFC), cingulate cortex, hippocampus, thalamus, and caudate. The fronto-striatal system plays an important role in attention, particularly involving the inhibition of unimportant stimuli. The results indicate that there is no single system or circuit that is characteristic of ADHD, but rather multiple circuits are impacted. This reinforces the difficulty in accurate diagnoses, and further knowledge of which circuits are affected will help establish a stronger differential diagnostic criteria.

Examining the executive functioning deficits in ADHD, Castellanos and colleagues (2006) aimed to strengthen differential diagnostic criteria. Deficits in areas of inhibitory control have been indicated as most crucial for disturbances in executive functioning, affecting processes such as at attentional regulation and working memory (Barkley, 1997). To distinguish these deficits, scientists have characterized two types of executive functioning processes: “cool” and “hot” (Castellanos et al., 2006). “Cool” executive functioning is associated with the dorsal
lateral prefrontal cortex (DLPFC), and is involved in the attentional symptoms of ADHD. This includes the ability to inhibit attentional control and maintain working memory. In contrast, “hot” executive functioning is associated with the orbital medial prefrontal cortex (OMPFC), and can be attributed to the hyperactivity and impulsivity symptoms of ADHD. Although many patients exhibit deficits in both “hot” and “cool” executive functioning, these characterizations can help clinicians differentiate between the inattentive and hyperactive-impulsive subtypes of ADHD.

Other studies have highlighted similar regions impacted in ADHD, particularly those in the frontal and parietal cortices, medial prefrontal cortex (MPFC), ventral prefrontal cortex (VPFC), corpus callosum, basal ganglia, and cerebellum (Giedd & Rapoport, 2010; Purper-Ouakil et al., 2011). Based on these regions, additional pathways have been linked to ADHD deficits. The prefrontal-striatal circuit has been linked to inattention and executive function impairments, and the frontal-limbic system has been linked to hyperactivity (Purper-Ouakil et al., 2011).

Given the numerous findings of frontal network implications in ADHD, scientists tested for differences in functional connectivity in the fronto-default-mode network (Castellanos et al., 2008). The default-mode network (DMN) is a network that consists of ventral medial prefrontal cortex (VMPFC), lateral parietal cortex, anterior cingulate cortex (ACC), posterior cingulate cortex (PCC), and the precuneus (Castellanos et al., 2008; Lehrer & Lorenz, 2014). The DMN is active during wakeful rest and is associated with self-reflection processes (i.e., thinking about one’s self, the past, or planning for the future), and has been shown to be implicated in ADHD as well as other diseases, like schizophrenia (Buckner, Andrews-Hanna, & Schacter, 2008; Liang et al., 2006; Tian et al., 2006). To test the differences in functional connectivity in the fronto-
ADHD COGNITIVE INSIGHT & EXECUTIVE FUNCTIONING

default-mode network, investigators observed connectivity between frontal foci and the DMN using fMRI scan (Castellanos et al., 2008). They found that the network is in fact implicated, specifically in decreases of functional connectivity between ACC and precuneus/PCC and between precuneus and VMPFC/PCC. The results suggest that these decreases in functional connectivity are linked to the attentional lapses seen in ADHD and other disorders. The linkage of these pathways further emphasize the complexity of ADHD, as well as the notion of multiple circuits being impacted.

Although investigating the neural circuits involved in ADHD is critical, understanding the structural changes of these brain areas are also important. Previous studies have revealed that deficits are more pronounced on the right side of the brain (Castellanos et al., 1996; Sandson, Bachna, & Morin, 2000). Utilizing magnetic resonance imaging (MRI) techniques, Castellanos and colleagues scanned the brains of ADHD patients and healthy controls. The investigators examined regions involved in networks that linked basal ganglia and frontal regions (Castellanos et al., 1996). The MRI results show that the brains of individuals diagnosed with ADHD are structurally different from healthy controls, with the majority of differences affecting the right side. ADHD patients had significantly smaller volumes in the right caudate, right globus pallidus, and right anterior frontal region. In addition to this, ADHD brains also had significantly smaller cerebral volume compared to controls. The right hemisphere has been found to be dominant for attention, and patients with right hemisphere lesions have shown similar attentional deficits to that of ADHD patients (Mesulam, Waxman, Geschwind, & Sabin 1976; Gitelman et al., 1996). Other investigators have also noticed this trend of abnormality in the right hemisphere of ADHD brains (Sandson et al., 2000). Researchers administered the Random Letter Cancellation Test to ADHD patients and healthy controls, and observed omission rates between
the two groups. During this test, researchers present a sheet of paper centered at the participant’s mid-sagittal plane containing 360 letters, and the participant’s job is to circle all of the A’s. The number of A’s not circled and completion time are measured. Due to the contralateral anatomy within the visual system, the left visual field is connected to the right hemisphere of the brain, and vice versa for the right visual field. The results of this measure show that ADHD patients made more left omission errors than right omission errors, and compared to controls, patients made significantly more errors for the left side. This is consistent with previous studies that reveal more marked deficits on the right side of the brain (Castellanos et al., 1996; Di Michele et al., 2005; Sandson et al., 2000).

Interestingly, right hemispherical damage is also associated with poor insight, specifically in many of the brain regions affected in ADHD including PFC, ACC, and DMN (Bowden, Jung-Beeman, Fleck, & Kounios, 2005; Lehrer & Lorenz, 2014). Insight describes a person’s ability to self-reflect on unusual experiences, their certainty in judgments, and their ability to correct misjudgments (Beck et al., 2004). When a person has a moment of insight, it is often marked with an “Aha!” experience – an experience that typically occurs when an individual reaches a non-obvious solution to a problem that requires a different conceptual knowledge (Bowden, Jung-Beeman, Fleck, & Kounios, 2005; Luo & Nikki, 2003). During this moment of insight when the individual needs to utilize novel associations, or different conceptual knowledge, right hippocampal activation has been observed (Luo & Nikki, 2003). Thus, indicating that the hippocampus plays a role in insight, and implications in this area may lead to impairment of insight.

Insight is an important outcome predictor for a variety of illness, and is related to cooperation with treatment, relapse frequency, symptom remission, and psychosocial functioning
For example, someone who lacks insight may have a more difficult time attributing cognitive deficits to an illness/disorder and may believe that the disorder is not the problem. Such beliefs can lead to further beliefs of not needing treatment, and may result in non-adherence to a particular treatment such as taking medication. Clinicians have defined insight as the ability to be aware of manifesting an illness, noticing the signs and symptoms of the illness, attributing impairment to that illness, and recognizing the need to treat the illness.

“Clinical insight” has been assessed in a number of studies, and reliably measures whether a patient is aware of a mental illness. Such measures include the Scale to Assess Unawareness of Mental Disorder (SUMD) and Schedule of Assessment of Insight Extended (SAI-E); however, these measures are primarily used with patients showing psychotic symptoms. Furthermore, they do not account for instances in which the patient accepts the presence of a mental illness (their intellectual insight is intact), but is not actually convinced (Beck, Baruch, Balter, Steer, & Warman, 2004). For example, when asked about their symptoms, a delusional patient may respond that they have a mental illness that causes these symptoms. This is a probable response, since it is likely the patient has previously had their symptoms explained to them. When further questioned, however, the patient may indicate that the government is watching them. Thus, clinical insight cannot explain erroneous inferences. Cognitive insight, on the other hand, does. Cognitive insight, measured with the Beck Cognitive Insight Scale (BCIS), assesses the cognitive processes that underlie self-reflection and includes the evaluation and correction of false beliefs by assessing one’s self-certainty. Assessment of cognitive insight identifies patients at risk for poor adherence to treatment, and therefore holds clinical relevance (Orfei, Piras, Macci, Caltagirone, & Spalletta, 2013).
Because insight deficits are most prominent in psychotic patients, it is worthwhile to observe findings related to schizophrenia. Using the SUMD to assess schizophrenia patients, previous studies have attributed impairment of insight to dorsal lateral (DLPFC) and orbitofrontal (OFC) regions of the PFC (Lehrer & Lorenz, 2014; Shad, Muddasani, & Keshavan, 2006). These results show a negative correlation between right DLPFC volume and awareness of symptoms, and a positive correlation between right OFC volume and attribution of symptoms. Another area of importance is the insular cortex. The insula is involved in self-awareness and is connected to various brain regions including PFC (OFC and ACC), limbic system, and the thalamus, all of which are implicated in schizophrenia (Lehrer & Lorenz, 2014). The DMN is also relevant, given that it is involved in self-reflection. Focusing on the DMN, investigators compared schizophrenia patients with poor insight to those with good insight by measuring fMRI blood-oxygen-level dependent (BOLD) signals during rest (Liemburg et al., 2012). The fMRI results reveal that those with poor insight showed weaker connectivity in the DMN, particularly between the ACC and precuneus.

Important to note, many of these regions attributed to poor insight in schizophrenia patients are also implicated in ADHD patients (i.e., PFC, ACC, PCC, thalamus, precuneus). A study conducted by Orfei and colleagues (2013) suggests that deficits of self-reflection (a subscale on the BCIS) are not specific to schizophrenia, but rather these deficits may be manifested in a variety of neuropsychiatric disorders. This study administered the BCIS to schizophrenia patients and used MRI and diffusion tensor imaging (DTI) techniques to observe the neural correlates involved in cognitive insight. In addition to this, investigators also aimed to discover whether these correlates were specific to the mechanisms involved in schizophrenia. The results indicate that self-reflection scores were positively related to gray matter volume in
the right VLPFC – an area involved in working memory, decision making, and inhibition of incorrect responses. Self-reflection was only related to gray matter volume, and not behavioral differences, thus suggesting that these findings are not specific to schizophrenia. Moreover, similar scores on BCIS dimensions were found in patients with other diagnoses, such as bipolar disorder and schizoaffective disorder (Beck et al., 2004; Orfei et al., 2013). Based on these findings and the similarities in neural correlates between ADHD and those attributed to poor insight in schizophrenia, it is reasonable to suggest that ADHD patients may also have impaired cognitive insight.

The goal of this study is to observe the relationships between cognitive insight and attention deficit hyperactivity disorder (ADHD), as well as executive function and ADHD. Cognitive insight plays a large role in self-reflection, and correctly attributing cognitive deficits to a disorder. A lack of insight would suggest that one is less able to draw this connection, and therefore may not truly believe they need treatment. In addition, a lack of insight has also been associated with psychosocial behavioral problems. This study is based on the observation that related psychiatric conditions are associated with impaired cognitive insight and poor executive function but the extent of impairment in ADHD patients is unclear. In this study we will compare cognitive insight in ADHD volunteers matched with non-diagnosed controls. Because executive function deficits are common in disorders involving impaired cognitive insight, we also observe the relationship between executive functioning and cognitive insight. We hypothesize that cognitive insight is negatively related to ADHD symptoms severity, and is positively related to executive functioning.
Method

Participants

A total of 90 volunteers (ADHD, \( n = 45 \); control, \( n = 45 \)) will participate in this study. Participants’ ages range between 18-25, and ADHD volunteers will be matched with controls on gender, ethnicity, and educational attainment. It is expected that there will be more male participants compared to females, because boys between the ages of 5-17 are 2-3 times more likely to be diagnosed with ADHD than girls (CDC, 2016).

Participants were sampled from the Minneapolis/St.Paul area; however, the majority are University of Minnesota – Twin Cities students. To be considered for participation, all potential volunteers responded to recruitment flyers that have been posted around Minneapolis and on Craigslist. To be eligible for participation, volunteers had to be non-medicated, between the ages of 18-25, have not been diagnosed with a neuropsychological disorder (other than ADHD), could not be color blind, and had to be fluent in English. There are no direct benefits to participating in the study, and volunteers are compensated for their time either monetarily or REP points.

Measures

ADHD Symptom Severity

Spencer’s ADHD Symptom Checklist (Appendix A) is used to assess symptom severity. This instrument is a self-report scale in which volunteers rate the frequency or severity of a particular symptom on a scale from 0-3 (0 = no experience; 3 = severe experience). Each symptom is accompanied by a more detailed description. For example, “DIFFICULTY REMAINING SEATED: Leave my seat in classroom or other setting in which seating is expected” assess hyperactive symptoms of ADHD, while symptoms of inattentiveness are assessed with symptom ratings such as “LOSES THINGS”.
Cognitive Insight

In order to assess cognitive insight, Beck designed the Beck Cognitive Insight Scale (BCIS). This 15-item self-report questionnaire was used on patients with schizophrenia, schizoaffective disorder, major depressive disorder (MDD) without psychosis, and MDD with psychotic symptoms (Beck et al., 2004). The BCIS (Appendix B) was shown to reliably measure cognitive insight across groups while strongly correlating with SUMD awareness of mental disorder (intellectual insight) subscale. In addition to this, the scale was effective at measuring both psychotic and non-psychotic patients; this differs from the SUMD, which is only sensitive to psychotic patients (Amador et al., 1993; Beck et al., 2004). The BCIS has been translated and used in a Taiwanese sample of psychotic patients, and the scale was similar in clinical and non-clinical participants (Kao & Liu, 2010). This reinforces the validity and reliability of the BCIS, while also showing consistency across groups.

Because psychotic symptoms are not present in ADHD patients, the BCIS was the most appropriate scale to use for the present study. As previously stated, the BCIS measures two subscales of cognitive insight: self-reflection and self-certainty. Self-reflection refers to how one may respond to unusual experiences, whereas self-certainty assesses one’s self-confidence in their decisions and the ability to modify their own interpretations (Beck et al., 2004; Orfei et al., 2013). Participants rate how much they agree with each item on a 4-point scale (0 = do not agree at all; 3 = agree completely). Both subscales receive their own score, and the composite score is calculated by subtracting the self-certainty score from the self-reflectiveness score (Beck et al., 2004; Kao & Liu, 2010).
Executive Function

There are several measures of executive function, but one of the most commonly used is the Stroop Task. This task requires the participant to inhibit conflicting stimuli. For example, the name of a color is presented (i.e., red), but the font may be a different color (i.e., blue). The participant’s job is to respond based on the color of the font, and not the word itself. The correct answer would be blue, but to reach that answer, the participant must inhibit their attention toward the word itself. The Stroop Task activates ACC and DLPFC, and is therefore sensitive to ADHD (Nigg, Blaskey, Huang-Pollock, & Rappley, 2002).

The Stroop Color-Word task has been confirmed effective at measuring executive functioning in ADHD. Used on combined and inattentive subtypes, it was shown that ADHD patients of both subtypes responded slower than healthy controls (Nigg et al., 2002). In an experiment that examined performance on the Stroop Task when patients were taking versus not taking medication, it was shown that patients taking psychostimulants performed better compared to their non-medicated cohorts (Peterson et al., 2009). Medicated patients were relieved of hyperactivity and inattention symptoms, and task-related deactivations in the ventral ACC and PCC were more prominent compared to non-medicated controls. For this reason, only non-medicated participants are allowed to participate in the present study. This is to avoid confounding in results.

In the present experiment, there are 4 blocks in which a word is presented, each containing 120 trials. Each type of block is used twice. One block strictly uses incongruent color-word pairs, while the second uses a mixture of congruent, incongruent, and neutral word-color pairs. The word remains on the screen for 400 ms, and a fixation cross appears on the screen for another 500 ms. During this time, the participant can still make a response to the stimulus, and
must respond verbally. Between each word, or trial is a 500 ms interstimulus interval. Response times and correct answers will be analyzed to assess executive functioning.

**Procedure**

Prior to participating in the experiment, potential volunteers must respond to recruitment flyers by emailing the research coordinator. The research coordinator then confirms eligibility, and schedules an appointment for participation. When the volunteer arrives, they must provide informed consent, indicating they understand the tasks involved in the study.

After providing informed consent, the participant is then asked to complete a demographic form (Appendix C), Spencer’s ADHD Symptom Checklist, and the BCIS. The research coordinator steps out of the room until the participant has completed these three self-assessments. Next, the participant is asked to perform the Stroop Task. The Stroop Task is administered on a computer using PsychoPy, and is counterbalanced to avoid sequence bias between blocks. Instructions were provided on the screen, and the research coordinator remains in the room in case there is any confusion on what the task requires. After the participant has a clear understanding of the task, the research coordinator leaves the room and returns upon completion. At this time, the research coordinator debriefs the participant and describes the goals of the study, and asks if the participant has any further questions. If not, the experiment is complete, and the participant is compensated for their time.

**Discussion**

We hypothesized that cognitive insight is negatively correlated with ADHD symptoms severity, and is positively related to executive functioning. If the hypothesis is supported, then the data will reveal that cognitive insight may be impaired in ADHD, and further research should be done to replicate these results. If after further research is done, and the results are consistent
with this hypothesis, then novel knowledge pertaining to ADHD, and potentially disorders involving executive function deficits in general, will have been found. Scientists may then develop improved treatment strategies to address this newfound deficit. If our hypotheses are incorrect, then impairment of cognitive insight may not be of concern for ADHD patients, and in which case would result in a better prognosis for these patients.

Although the results of this study may provide new insight into the cognitive deficits affecting ADHD, the conclusions would be purely observational and not experimental. Because we are only using correlational analyses, here, conclusive results cannot be drawn (Stanovich, 2012). It is possible that there is a third-variable accounting for correlational trend. This possibility has been controlled by observing relationships of cognitive insight to both symptom severity and executive function; however, an experimental study would provide stronger and more conclusive results.

In addition to the present study being purely correlational, there are other limitations to note. Due to a lack of credentials, the research coordinator is unable to verify ADHD diagnoses, or assess for other diagnoses. Spencer’s ADHD Symptom Checklist is a good tool, but only provides insight into symptom severity, and is a self-report measure. Participants may manifest other, undiagnosed mental illnesses that may confound the results. Also important, is that the BCIS has never been used in and ADHD sample before. Although it has been confirmed effective in a non-clinical sample, we run the risk of it not being sensitive to ADHD patients.

In order to receive more conclusive results, scientist should design an experimental study in which the diagnosis is confirmed, as well as assess for other diagnoses that may confound results. The use of neuroimaging technology may also prove useful in such a study. This would allow investigators to observe whether the neural correlates previously described are in fact
implicated during the task. This would also provide researchers with an experimental measure, rather than observational; thus, allowing conclusive results to be drawn.
References


Appendix A

ADHD SYMPTOM CHECKLIST

Participant: ___________________ Date Filled: __________

Please rate the frequency/severity of each of the following experiences in a scale of 0-3 (0 = no experience; 3 = severe experience). The information will remain confidential and will be used only for this study.

<table>
<thead>
<tr>
<th>Experience</th>
<th>Rating</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. DIFFICULTY REMAINING SEATED:</td>
<td></td>
</tr>
<tr>
<td>Leave my seat in classroom or other setting in which seating is expected</td>
<td></td>
</tr>
<tr>
<td>2. FIDGETY:</td>
<td></td>
</tr>
<tr>
<td>Fidget with hands or feet or squirm in my seat</td>
<td></td>
</tr>
<tr>
<td>3. DIFFICULTY PLAYING QUIETLY:</td>
<td></td>
</tr>
<tr>
<td>Quiet activities that are not very stimulating</td>
<td></td>
</tr>
<tr>
<td>4. TALKS EXCESSIVELY:</td>
<td></td>
</tr>
<tr>
<td>Talks excessively, more than most people</td>
<td></td>
</tr>
<tr>
<td>5. DIFFICULTY SUSTAINING ATTENTION:</td>
<td></td>
</tr>
<tr>
<td>Difficulty sustaining attention in tasks or fun activities (not including stimulating activities such as computer or video games)</td>
<td></td>
</tr>
<tr>
<td>6. DIFFICULTY FOLLOWING INSTRUCTIONS:</td>
<td></td>
</tr>
<tr>
<td>Don’t follow through on detailed instructions or directions with multiple steps and/or fail to finish work</td>
<td></td>
</tr>
<tr>
<td>7. EASILY DISTRACTED:</td>
<td></td>
</tr>
<tr>
<td>Easily distracted</td>
<td></td>
</tr>
<tr>
<td>8. INTERRUPTS OR INTRUDES:</td>
<td></td>
</tr>
<tr>
<td>Interrupt or intrude on others</td>
<td></td>
</tr>
<tr>
<td>9. BLURTS OUT ANSWER:</td>
<td></td>
</tr>
<tr>
<td>Blurt out answers before questions have been completed</td>
<td></td>
</tr>
<tr>
<td>10. DIFFICULTY WAITING TURN:</td>
<td></td>
</tr>
<tr>
<td>Have difficulty awaiting turn or standing in line in situation that so requires</td>
<td></td>
</tr>
<tr>
<td>11. LOSES THINGS:</td>
<td></td>
</tr>
<tr>
<td>Lose or misplace things necessary for tasks and activities</td>
<td></td>
</tr>
<tr>
<td></td>
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</tr>
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<td>---</td>
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</tr>
<tr>
<td><strong>12. DOESN’T LISTEN:</strong></td>
<td>Doesn’t listen when spoken to directly (this is not oppositional, more reflective of daydreaming or inability to listen throughout the conversation)</td>
</tr>
<tr>
<td><strong>13. FAILS TO PAY CLOSE ATTENTION TO DETAILS:</strong></td>
<td>Fail to give close attention to details or make careless mistakes in my work</td>
</tr>
<tr>
<td><strong>14. DIFFICULTIES ORGANIZING:</strong></td>
<td>Having difficulties organizing tasks and activities</td>
</tr>
<tr>
<td><strong>15. AVOIDANCE OR STRONG DISLIKE OF MENTAL TASKS:</strong></td>
<td>Avoid, dislike, or reluctant to engage in work that requires sustained mental effort</td>
</tr>
<tr>
<td><strong>16. OFTEN FORGETFUL:</strong></td>
<td>Forgetful in daily activities</td>
</tr>
<tr>
<td><strong>17. OFTEN “ON THE GO” OR ACTS LIKE “DRIVEN BY A MOTOR”</strong></td>
<td>Feel “on the go” or “driven by a motor” (actual physical activity</td>
</tr>
<tr>
<td><strong>18. HYPERACTIVITY/RESTLESSNESS:</strong></td>
<td>Feel restless (more related to feeling than action, uncomfortable or feeling the need to be doing something all the time)</td>
</tr>
</tbody>
</table>
Appendix B

**Beck Cognitive Insight Scale**

Participant: ___________________ Date: ______________

Below is a list of sentences about how people think and feel. Please read each sentence in the list carefully. Indicate how much you agree with each statement by checking the box in the corresponding space in the column next to each statement.

<table>
<thead>
<tr>
<th></th>
<th>Do not agree at all</th>
<th>Agree slightly</th>
<th>Agree a lot</th>
<th>Agree completely</th>
</tr>
</thead>
<tbody>
<tr>
<td>(1). At times, I have misunderstood other people’s attitudes towards me.</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
</tr>
<tr>
<td>(2). My interpretations of my experiences are definitely right.</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
</tr>
<tr>
<td>(3). Other people can understand the cause of my unusual experiences better than I can.</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
</tr>
<tr>
<td>(4). I have jumped to conclusions too fast.</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
</tr>
<tr>
<td>(5). Some of my experiences that have seemed very real may have been due to my imagination.</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
</tr>
<tr>
<td>(6). Some of the ideas I was certain were true turned out to be false.</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
</tr>
<tr>
<td>(7). If something feels right, it means that it is right.</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
</tr>
<tr>
<td></td>
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<td></td>
</tr>
<tr>
<td>(8). Even though I feel strongly that I am right, I could be wrong.</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
</tr>
<tr>
<td>(9). I know better than anyone else what my problems are.</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
</tr>
<tr>
<td>(10). When people disagree with me, they are generally wrong.</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
</tr>
<tr>
<td>(11). I cannot trust other people’s opinion about my experiences.</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
</tr>
<tr>
<td>(12). If somebody points out that my beliefs are wrong, I am willing to consider it.</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
</tr>
<tr>
<td>(13). I can trust my own judgment at all times.</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
</tr>
<tr>
<td>(14). There is often more than one possible explanation for why people act the way they do.</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
</tr>
<tr>
<td>(15). My unusual experiences may be due to me being extremely upset or stressed.</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
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Appendix C

Demographics

Participant: __________________ Date: __________________

Age: __________
Gender:
☐ Male ☐ Transgender
☐ Female ☐ Other

Please select one:
☐ Hispanic ☐ Non-Hispanic

Race/Ethnicity:
☐ American Indian or Alaska Native
☐ Hawaiian or Other Pacific Islander
☐ Asian or Asian American
☐ Black or African American
☐ White
☐ Other

Which medications are you taking? If none, please fill in N/A
________________________________

What is the dosage of the medication?
__________________________

How long have you been taking this medication?
__________________________

Contact Email (optional): __________________

Age diagnosed: __________
(N/A if not applicable)

Have you been diagnosed with a mental illness separate from ADHD? If yes, explain:
Yes ☐ No ☐
________________________________
__________________________________

Education Completed:
☐ Never attended school or only attended kindergarten

☐ Grades 1 through 5 (Elementary)

☐ Grades 6 through 8 (Middle School)

☐ Grades 9 through 11 (Some high school)

☐ High school graduate or GED

☐ College 1 year to 3 years (Some college or technical school)

☐ Bachelor’s Degree

☐ Graduate School (Advance Degree)
Appendix D

Research Experience

In the last year, I worked as a research assistant under Dr. Rajendra Badgaiyan in a laboratory within the Department of Psychiatry. During this time, I received a fully immersive research experience. I was given the freedom to design my own research experiment on any topic of interest. Interested in schizophrenia, I started out reading a wide variety of literature on schizophrenia, and took note of questions I came across. After some trial and error of designing experiments, I came up with a novel question that had never been explored before. That is whether impairments of cognitive insight that are so prevalent in schizophrenia may also be present in attention-deficit hyperactivity disorder (ADHD), or in other disorders involving deficits in executive functioning. Through reading the literature, I was able to develop an experiment that utilized various measurements that would help me answer the question at hand.

Once my methods were approved by my project investigator (PI), the next step was to receive Institutional Review Board (IRB) approval.

While I was given a great opportunity to gain hands-on experience and become familiar with the day-to-day tasks involved in research, it came with its struggles. As an undergraduate, the IRB would not allow me to perform certain tasks, including diagnostic scales. This limited my research to self-report scales, which are known to have reliability issues. I also wanted to have a younger age group, with ages ranging from 12-23, since ADHD symptoms are more likely to be prevalent at younger ages (Purper-Ouakil, Ramoz, Lepagnol-Bestel, Gorwood, & Simonneau, 2011). However, due to my lack of credentials, the IRB was not comfortable approving this criterion. These are just a couple of examples of IRB issues I ran into. After four months of going back and forth with the IRB, I received approval. Currently, I am in the data collection phase of the study; however, it is not going as quickly as I had anticipated. Very few
eligible volunteers with ADHD have participated in the study. I postulate that this may be
because use of ADHD medication is an exclusion criteria, and on a college campus, it is more
advantageous to take the medication. Steps have been taken to focus recruitment efforts on
volunteers with ADHD, such as posting flyers in other areas of Minneapolis.

In the meantime, however, I continued to enhance my research experience in other ways.
I analyzed data that was previously collected in the lab, including PET neuroimaging data. Using
MATLAB and SPM 8 software, I corrected data. With neuroimaging data, there are always
corrections needed due to the variation between participants’ brains and the random noise that
can implicate the data. After correcting the images, the next step was to compare the results
across groups.

Apart from analyzing data, I also adopted another study that was designed by my PI,
which is intended to examine differences in memory processing in schizophrenia. It is
hypothesized that schizophrenia patients perform better on tasks involving implicit memory
compared to explicit memory, and may even perform better than undiagnosed controls on
implicit memory tasks. Again, I received experience handling all of the IRB correspondence
involved with the experiment.

This experience has been a demanding, but also a rewarding one. I was able to develop
skills I would not have developed otherwise. Because I often found myself needing to contact
outside sources to resolve issues, I was able to improve my communications and problem-
solving skills. I am now comfortable completing IRB applications and handling the necessary
correspondence regarding these applications. Designing experiments was another important skill-
set I have gained during this experience. I gained a better understanding of what one can, and
cannot do when designing an experiment, as well as the ethical concerns involved. In addition to
these, I also developed technical skills including familiarity with computer software such as MATLAB, SPM 8, R, and PsychoPy. These programs will all be useful as I continue conducting research.

Because of my research experience, I have gained a better understanding of what a career in academia/research entails. This has provided me more confidence as I decide to pursue a career in psychopharmacology research. The fact that I was not hindered on what I could study allowed me to work on something I truly cared about, rather than simply working on an existing study that I may not have been as invested in. The latter was the case in previous labs I had worked in. I intend to continue working in my lab for at least another year where I will develop more experiments, and have more of an administrative role in existing studies. Through this, I become more marketable to other jobs and graduate schools, as well as become closer to achieving my goals.