Flowing into Hyperfocus: Hyperfocus and Cognition in Adults with ADHD

Quynh T. Tran

The University of Michigan

Mentor: Dr. Priti Shah

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Abstract

Adults diagnosed with Attention Deficit Hyperactive Disorder (ADHD) often report long-lasting episodes of intense concentration on a task--a concept known as hyperfocus (HF). While HF is frequently anecdotally reported, it is not an official clinical symptom of ADHD and thus requires more study. Building upon our lab's past work, this thesis contains three studies. The first study examined the cognitive mechanisms of HF. We hypothesized that adults with ADHD experience more HF which would result in worse task-switching performance. To measure HF, we administered the Adult Hyperfocus Questionnaire (AHQ). Study 1 found that participants who reported higher HF were actually better at task-switching. Because the AHQ skipped key scale development steps and was too long, we created an improved HF scale in Study 2. We performed cognitive interviews to identify confusing wording in the items and used this information to shorten the AHQ into the AHQ-2. In Study 3, we administered the AHQ-2 to two separate cohorts. These data replicated previous findings that ADHD adults experience more HF than non-ADHD adults, and that higher ADHD symptomatology correlates with higher HF scores. Additionally, those with ADHD have more positive and more negative HF experiences than their non-ADHD counterparts. Finally, the AHQ-2 performed similarly compared to the AHQ in indexing HF, suggesting that future studies may use our revised scale. Data collection and analyses are still ongoing. Future work will focus on continuing to refine the AHQ-2 and testing its psychometric properties and relationships with ADHD diagnosis and symptoms in larger replication samples.

Keywords: ADHD, hyperfocus, flow, distractibility, attention, cognitive interview

Flowing into Hyperfocus: Hyperfocus and Cognition in Adults with ADHD

In today's society, life seems to happen all too fast, with everyone busily moving from one thing to the next. From school to work to family obligations, life can start becoming very routine. For many adults in the United States, focusing on life's mundane and required tasks may prove to be difficult, but partaking in enjoyable activities for hours on end such as playing video games or watching television can be surprisingly easy. Perhaps during an activity, your mind finds itself elsewhere so much so that focusing on the task at hand seems almost impossible. Or maybe it is difficult getting started on a work or school project, but once you "enter the zone," you cannot seem to pull yourself out of it. From one end of the spectrum to the other, these characteristics may be indicative of Attention-Deficit/Hyperactivity Disorder (ADHD).

ADHD is a mental health disorder characterized by problems such as impulsiveness, difficulty focusing on a task, and hyperactivity (Mayo Clinic, 2019). While ADHD is usually diagnosed early in childhood, many continue to experience these life-interfering symptoms as adults. Although symptoms of ADHD can be quite common among neurotypical individuals, diagnosis of ADHD only occurs when these symptoms are persistent enough to continually disrupt daily function (Mayo Clinic, 2019). In the United States, the overall prevalence of ADHD in adults is 4.4% (National Institute of Mental Health, 2017).

While ADHD is commonly associated with distractibility, people oftentimes fail to acknowledge other aspects of ADHD. For example, sometimes, instead of this general lack of focus, people experience a state of too much focus. This is commonly known as hyperfocus (HF). HF is a phenomenon that describes when a person is so engrossed and fixated on a task that they completely "tune out" what is happening around them (Ashinoff & Abu-Akel, 2019). HF can occur for neurotypical people across many aspects of life, such as school, work, and on

recreational activities like video games. While most neurotypical people experience a "hyperfocus-like state" at least once in their lifetime, this term is often used in the context of conditions related to attention abilities (Ashinoff & Abu-Akel, 2019). Furthermore, HF may seem like a frequent occurrence in the wider population, but its prevalence may be higher in ADHD populations (Conner, 1994; Hupfeld et al., 2019). A term that is commonly used interchangeably with HF is flow. Flow is used when a person is completely absorbed in the present moment and intensely focuses on reaching an "end goal" (Ashinoff & Abu-Akel, 2019). The concepts of flow and HF share some of the same characteristics, but we believe that the cognitive mechanisms underlying these two phenomena might not be the same.

Currently, the chief symptom for ADHD diagnosis in adults is difficulty focusing (American Psychiatric Association, 2013). Thus, there are few instruments available to assess HF when diagnosing adults for ADHD. To address this gap, Ozel-Kizil et al. (2016) created the Hyperfocusing Scale (HS) to evaluate the degree of HF symptoms. Ozel-Kizel et al. (2016) found higher HF in adults with ADHD versus non-ADHD participants and that HF was correlated with ADHD symptoms.

As the first scale created to specifically study HF, the HS posed several limitations which were addressed by Hupfeld et al. (2019) in a more recent study. Firstly, the HS was originally written and administered to participants in Turkish (Hupfeld et al., 2019). As Turkish does not translate over to English directly, the wording of the English version of the published HS was somewhat confusing and difficult for English speakers to comprehend (Hupfeld et al., 2019). Secondly, the Turkish HS contained only 11 items that focused more on the negative aspects of HF despite reports that people with ADHD may have both positive and negative HF experiences (Hupfeld et al., 2019). Thus, Hupfeld et al. (2019) developed the Adult Hyperfocus

Questionnaire (AHQ) to address these limitations and assess the correlation between HF scores and ADHD symptom severity. Adults in this study self-reported their ADHD symptoms and whether or not they had been previously diagnosed with ADHD (Hupfeld et al., 2019). Researchers found that those who reported high ADHD symptomatology also scored higher on the AHQ HF scale, and those with ADHD reported higher HF scores than those without ADHD (Hupfeld et al., 2019). These results provided an important foundation to study the relationship between HF and ADHD. To further understand this relationship, we directly built upon this past work and designed a study to investigate the cognitive correlates of HF.

Study 1

Study 1 focused on the effects of HF on cognition in adults with ADHD. We conducted two tasks on our ADHD group and control group--a task-switching task and continuous performance task (CPT)--in addition to administering our AHQ (see AHQ in Hupfeld et al., 2019). The AHQ indexes HF symptomatology as it relates to respondents' personality in general (i.e., "dispositional" HF), and to their experiences during school, hobbies, and screen time activities. Of note, as previously reported by our group (Hupfeld et al., 2019), each of the AHQ subscales had high internal reliability among both ADHD and non-ADHD participants (α = .87-.99). The goal of the AHQ is to accurately measure participants' HF experience in the context of their own life. We also asked participants a battery of complementary questions surrounding anxiety, depression, and traditional ADHD symptoms. The task-switching task evaluated selective attention by requiring the participants to switch between two different tasks. The CPT assessed the participant's cognitive control abilities by testing their impulse and distractibility when a letter cue appears on the screen.

We hypothesized that those with ADHD would display higher HF scores on the AHQ and perform worse on task-switching compared to the non-ADHD controls.

Method

Participants

Participants were recruited from the University of Michigan Introductory Psychology Subject Pool. There were 19 participants in the control group, with ages ranging from 18 to 22 years old (M = 18.9, SD = .99) and 11 participants in the ADHD group, with ages ranging from 18 to 20 years old (M = 18.8, SD = .75).

Participants spent about two hours in the laboratory completing the attention tasks and our battery of questionnaires. Participants were compensated two credit hours for their Introductory Psychology class.

One ADHD participant was excluded due to technical issues that erased the CPT task data from the computer.

Materials and Procedure

Before starting, participants provided their written informed consent to take part in the study.

The task-switching task was administered online to evaluate the participant's ability to switch between two distinctive tasks. The task required participants to switch between 1) even and odd numbers (OE), 2) consonant and vowel letters (CV), and 3) a combination of numbers and letters (CVOE). Participants were asked to click between two keyboard letters (D and K) to indicate whether the number or letter that appears on the screen is even/odd or vowel/consonant, respectively. This task was used to evaluate the participant's reaction time in contexts that required switching from one task to another and when performing a task without a switch.

Afterwards, participants completed the AHQ. This questionnaire consists of short questions that index participants' HF symptomatology as it relates to their personality in general (i.e., "dispositional" HF), as well as HF during school, hobbies, and screen time. The questionnaire asked participants to either answer about their personality in general or enter their favorite school subject, hobby, or screen time activity and then choose between *never* (1), *1-2 times every 6 months* (2), *1-2 times per month* (3), *once a week* (4), *2-3 times a week* (5), *or daily* (6) in response to questions about intense focus like "*Generally, when I am very focused or doing something that I find especially rewarding… I tend to completely lose track of time."* Their answers translated to a six-point Likert scale (1 = never, 6 = daily) for subsequent data analyses. The purpose of this questionnaire was to assess the frequency of an individual's HF on a scale to evaluate the correlation between HF and severity of ADHD symptoms.

After the HF questions, participants completed the Conners' Adult ADHD Rating Scales–Self Report (CAARS) survey which is designed to assess severity of ADHD symptoms and help diagnose ADHD (Conners et al., 1999). Then, participants completed the Hyperfocusing Scale (HS, Ozel-Kizil et al., 2016). These HS scores were used to help validate our AHQ HF scale (i.e., that our scale was indeed indexing the construct of HF). Following these ADHD-related surveys, participants answered additional questions about other mental health diagnoses and symptoms (e.g., anxiety and depression) and also provided their demographic information. Participants also provided a brief ADHD medication history. This history included what type of medication(s) participants had taken for ADHD, the dosage, frequency, and the duration (start and end date, if applicable) of each medication.

The last part of the study involved completing the CPT. This task was also administered on the desktop computer and evaluated the participant's distractibility and impulse when a letter

cue appeared on screen. Participants were asked to click the spacebar for every letter except for 'X.' When 'X' appeared on the screen, participants were instructed to avoid pressing the spacebar. This task was used to evaluate the participant's HF and impulse when presented (or not presented) with the letter 'X.'

Finally, participants were debriefed and thanked for their participation in the study.

Results

Results for Study 1 were calculated by correlating the switch and mixing cost of the task-switching task with the average dispositional HF score for each participant. Switch cost is the difference between the reaction time (RT) of task switch trials and the RT of task repeat trials within the mixed block (which would be the CVOE block) (Rogers & Monsell, 1995). Mixing cost is the difference between RT of task repeat trials in mixed blocks and RT in single task blocks (Philipp et al., 2008). Both switch and mixing costs are used as outcome variables for task switching trials in order to examine multitasking abilities (Philipp et al., 2008). In our study, the RT was taken from trials in which the participant selected the correct answer (RTcorrect).

Scoring

HF Score was calculated from the Dispositional subscale of the AHQ. Higher HF scores indicate higher (i.e., more frequent) HF. The scale was evaluated using a six-point Likert scale (1 = never, 6 = daily).

Switch Cost

The mixed block in the task-switching task was CVOE while the single task blocks were CV and/or OE. To measure switch cost, we took the average RTcorrect of CVOE switch trials minus average RTcorrect of CVOE non-switch trials (that is: switch cost = [avgRTcorrect (CVOE, switch) - avgRTcorrect (CVOE, non-switch)]). Correlational analyses were then used to

examine whether there was a relationship between switch cost and average dispositional HF score (Figure 1).

Correlational analyses indicated a moderate, significant negative relationship between dispositional HF score and switch cost (r = -.44, p = .015; Figure 1). This suggests that people who reported higher HF also had lower switch costs. That is, participants with *higher* HF performed *better* on the task switching component of the task.

Mixing Cost

Mixing costs were calculated by taking average RTcorrect in the CVOE block minus average RTcorrect of CV plus OE blocks (that is: mixing cost = [avgRTcorrect (CVOE) - avgRTcorrect (CV + OE)]). An additional correlational analysis was performed to test for a relationship between mixing cost and average dispositional HF score. We hypothesized that those who reported higher HF would have a harder time switching, and thus, would have a higher mixing cost. However, there was no significant relationship observed at the $p < 0.05$ level between average dispositional HF score and mixing cost (Figure 2).

In summary, HF score was significantly negatively associated with switch cost. However, there was no significant relationship between HF score and mixing cost.

Switch and Mixing Costs between ADHD and Non-ADHD Participants

To determine if there were performance differences between the ADHD and non-ADHD (control) participants, we also calculated the average switch and mixing costs for the ADHD and non-ADHD groups, respectively (Figure 3).

The results indicated that there were no significant differences in switch or mixing cost between ADHD and non-ADHD participants (p = 0.80 (switch cost), 0.95 (mixing cost); Figure 3).

Turkish HS vs. AHQ

Finally, a correlational analysis was performed to examine a relationship between the Ozel-Kizil et al. (2016) HS and our AHQ scale (Figure 4). This was done to validate that our AHQ scale measured the same construct as the HS Scale.

Correlational analyses indicated that there was a significant relationship between the AHQ dispositional HF score and Ozel-Kizil HS (r = .41, p = .025; Figure 4). This finding suggests that the AHQ measures approximately the same construct as the Ozel-Kizil HS because participants' average self-reported AHQ HF score matched their average HS score. This suggests that both scales measure a similar HF construct.

Study 2

Study 1 provided insight into the cognitive bases of HF. However, the practical (e.g., clinical) value of our original AHQ was problematic. Our original AHQ was too long (i.e., multiple subscales with a dozen or more questions each). Furthermore, the original AHQ had several gaps that we noted after the fact. For example, the original items captured more negative aspects of HF and fewer possible positive aspects of HF. Thus, the goal of Study 2 was to revise our original AHQ to create a shortened scale that is more practical, valid, and clinically useful. In order to revise the AHQ, we revisited key scale development steps to optimize our questionnaire's validity and utility.

Scale Development

Self-report questionnaires are essential in understanding the many mechanisms that underlie phenomena in the social and behavioral sciences. Such scales measure behaviors, tendencies, and subjective answers to hypothetical situations that can be difficult to measure directly (Boateng et al., 2018). Therefore, in order to most accurately obtain relevant and

accurate information, these questionnaires must follow proper scale development procedures. Boateng et al. (2018) suggests there are three phases to scale development--item development, scale development, and scale evaluation--which can be further broken down into nine steps. By ensuring that we followed the necessary steps in scale development, we aimed to make our AHQ more practical for measuring the HF experience of adults with ADHD. The steps we took are outlined below.

Cognitive Interviews

In order to determine whether our AHQ scale questions accurately measured the intended HF construct, it was important to run these questions by a target population to identify any potential problems or confusion with the questions. We achieved this by conducting cognitive interviews. Cognitive interviews are a process by which participants verbalize their thoughts for a questionnaire item in a "think aloud" process as they are coming to an answer for that questionnaire item (Boateng et al., 2018). These cognitive interviews allow us to look at these questions from a different perspective and determine if our questions measure the HF aspects that we intended for them to measure. In doing so, we were able to modify or augment the AHQ items to better fit our intended goals for comprehensively measuring HF before finalizing the questionnaire.

Method

Participants

Two subjects volunteered to participate in the cognitive interview. Participants were 20 and 22 years old and are both undergraduate students at the University of Michigan. The cognitive interviews were conducted via the Zoom platform and required about 30 minutes each.

Materials and Procedure

Item Development

According to Boateng et al. (2018), the first phase of scale development is item development. Thus, the first step was to choose which questions to include or exclude in the new AHQ, which we renamed the AHQ-2. Item Response Theory (IRT) and Exploratory Factor Analysis (EFA) were used to analyze questions from the dispositional and scenario subsections of the AHQ. As our primary goal was to shorten the scale, we selected to perform IRT and EFA on only these sections. Based on these analyses, six of the 12 dispositional questions and seven of the 18 scenario questions presented with low discriminability and low factor loadings. For example, a question that had low discriminability was "*Generally, when I am very focused on something or doing something that I find especially rewarding, I can feel totally captivated by or "hooked" on the activity*." The remainder of the questions that performed poorly on the IRT and EFA analysis are included in Appendix A.

After compiling these questions into a Google spreadsheet, we started the process of shortening the questions. Our goal was to simplify the questions to improve understanding, while still encompassing the same HF construct. For example, our original question, "*In general, when I am very focused on something or I am doing something that I find especially rewarding, I can be unsure of what time of day it is or how much time has passed since I started the activity,*" was simplified to "*When I am busy doing something I am very focused on, I am unsure of how much time has passed."* This process continued throughout the dispositional and scenario scales until we were satisfied with our edits. The revised scale is presented in Appendix B.

Scale Development

Next, we entered phase two: scale development. After finalizing our drafted questions, we conducted two pilot cognitive interviews. We revisited the original scale to modify some of

the AHQ dispositional items to include in the AHQ-2. Additionally, we added several positive items to the AHQ-2 to examine whether there are positive aspects of HF. We had other questions (e.g., scenario HF questions), but felt that these selected revised dispositional HF questions most accurately and succinctly represented the HF phenomenon we wanted to test. The scenario questions were redundant, so they were removed from the final iteration of the AHQ-2. The interviews were conducted over the Zoom platform due to the current COVID-19 restrictions. Participants provided consent for their participation and consented to a recording of the interview. The order of the questionnaire was as follows: open-ended questions, dispositional HF questions, and positive/negative HF questions (Appendix B). We put the open-ended questions first to familiarize participants with the think-aloud process. We presented a PowerPoint slideshow of the questions for the participant to view via Zoom screenshare. For each question, the participant was encouraged to verbalize all of their thoughts when coming to an answer. Answer choices to these questions include *never, 1-2 times every 6 months, 1-2 times per month, once a week, 2-3 times a week, and daily.* However, the *process* of how they came to their answer was more of the focus than the answer itself. Participants were also probed with questions like "*How did you come up with this answer?*" and "*Could this question be worded differently for more clarity?*" when there was hesitation or any indication of confusion. While participants verbalized their thought process, we recorded the interaction and wrote down any pertinent notes and questions that were raised by the participant.

Results

The pilot cognitive interviews gave us valuable insight into what parts of our AHQ items were particularly confusing or ambiguous. A theme that emerged from these interviews, however, was the ambiguity in the answer choices. According to our participants, the answers in

the original scale did not quite capture their personal HF experiences. For example, hyperfocusing on a specific activity might not occur every day of the week for a participant to mark "daily," so perhaps a better way to phrase that question would be, for example: of the times they do experience HF, they might feel productive "a certain percentage of the time." Though we currently have collected only two cognitive interviews, our data collection and analyses remain ongoing as we continue to refine the AHQ and produce the AHQ-2.

Study 3

After the scale development steps and the cognitive interviews described above, we completed another round of revision of the AHQ-2 items to address any confusion or ambiguity that surfaced during the cognitive interview. Revisions included changing our answer choices to a six-point Likert scale (0 = never, 5 = always) and reordering the AHQ-2 to present the open-ended questions last so that these questions would not prime the participants to think a certain way about HF before they answered the multiple-choice dispositional questions. The overall goal of Study 3 was to take our revised, shortened AHQ-2 scale and test the validity of this new scale against the original AHQ. This was to help us determine whether we should continue the cognitive interview and scale revision process, or if we could proceed with publishing a final version of the AHQ-2. To do this, we administered our revised AHQ-2 to two different samples. The final version of AHQ-2 is presented in Appendix C.

By testing both questionnaires in these two new, independent samples, we were able to determine whether there was a correlation between the two questionnaires and whether both questionnaires measured the same construct of HF. We predicted that AHQ-2 scores would correlate with scores on the original AHQ, and that the AHQ-2 might, in turn, be able to serve as a sufficient, shortened, and more clinically relevant version of the AHQ.

Method

Participants

Participants (n = 100) were recruited from the online testing site Amazon Mechanical Turk (MTurk). Participants through MTurk were rewarded $3 for their participation. Participants' ages ranged from 21 to 77 years old (M = 36.7, SD = 10.7). There were 41 female participants whose ages ranged from 22 to 77 years old (M = 40.9, SD = 12.9) and 59 male participants whose ages ranged from 21 to 66 years old (M = 33.9, SD = 7.72). Of the 100 participants, 16 of these individuals self-reported an ADHD diagnosis.

In addition, to collect a second independent sample, participants (n = 83) were recruited from the University of Michigan Introductory Psychology Subject Pool. Participants recruited through Subject Pool were rewarded 0.5 credit hours for 30 minutes of their time. Participants ranged from 18 to 22 years old (M = 18.8, SD = 0.88). There were 56 female participants whose age ranged from 18 to 21 years old (M = 18.7, SD = 0.76) and 25 male participants whose ages ranged from 18 to 22 years old (M = 19.1, SD = 1.10). Of the 83 participants, six of these individuals self-reported an ADHD diagnosis. Of note, seven Subject Pool participants were excluded from further statistical analyses because they failed to pass the attention checks in the survey.

Materials and Procedure

Participants provided their written informed consent to participate in the study prior to completing the survey. The survey consisted of both the AHQ and AHQ-2 plus the CAARS and the same demographics survey from Study 1, in that order.

The AHQ and AHQ-2 were presented in random order with randomized questions in the HF scenario block (AHQ) and positive/negative HF block of AHQ-2. As described in Study 1,

the AHQ contains 12 questions in each of the following categories: dispositional, school, hobby, and screen time HF, and 18 questions in the HF "real-world" scenario section. The AHQ-2 is a shorter, revised version of the AHQ and contains 13 dispositional HF questions, four positive/negative HF questions, and five open-ended HF questions. The dispositional AHQ-2 scale demonstrated excellent internal consistency in the MTurk sample ($\alpha = 0.81$) and acceptable internal consistency in the Subject Pool sample ($\alpha = 0.6$).

In AHQ-2, participants indicated from a scale of 0 to 5 (*never* to *always*) and 0 to 5 (*very negative* to *very positive*) in response to both the dispositional and positive/negative HF questions, respectively. Following these sections, participants were asked to describe an activity in which they become very focused including what the activity is, how long the episode lasts, how they felt during the activity, and if they were able to accomplish anything by the end. After completing both the AHQ and AHQ-2, participants were given a space to share any thoughts or concerns they had about the questions they had just previously answered.

Participants completed the CAARS after the AHQ and AHQ-2. The CAARS survey contained 30 questions aiming to provide a self-report of any pertinent ADHD symptoms. Participants selected *"not at all, never," "just a little, once in a while," "pretty much, often," or "very much, very frequently"* to questions like "*I lose things necessary for tasks or activities (e.g., to-do lists, pencils, books, or tools)"* and *"I avoid new challenges because I lack faith in my abilities."*

The final section of the survey asked the participants for their demographic information as well as self-report mental health diagnoses (e.g., a previous ADHD diagnosis from a healthcare provider).

Results

Scoring

Higher scores on the AHQ and AHQ-2 indicate more HF, and higher scores on the CAARS indicate more severe ADHD symptoms. The AHQ and AHQ-2 were rated on a six-point Likert scale (1 = never, 6 = daily; 0 = never, 5 = always). Participants' total HF score was calculated by adding up the score for each item per section. The following statistical analyses were conducted separately for our MTurk and Subject Pool participants because these two cohorts represent very different populations. Ultimately, we wish for our revised questionnaire to be applicable to diverse populations, so we were interested in whether results differed across the broader demographics of MTurk participants compared to the more homogenous age range and demographics of the Subject Pool college students.

AHQ Dispositional HF Score for ADHD vs. Non-ADHD Participants

We first tested whether our previous result from Hupfeld et al. (2019) was reproducible in the two cohorts examined here. That is, we tested if there was a significant difference in AHQ dispositional HF scores between ADHD and non-ADHD participants. Of note, as our main goal of Study 3 was to investigate relationships between the AHQ and AHQ-2 and relationships between AHQ-2 scores and ADHD symptoms (regardless of an actual ADHD diagnosis), we did not specifically recruit for people with ADHD in these two cohorts; thus, the group sizes were unequal for the group analyses below.

Figure 5 depicts the results for the MTurk participants. There was a significant difference in AHQ HF score between the ADHD and non-ADHD participants ($p < .001$; Figure 5). This suggests that those with ADHD experience significantly more HF than non-ADHD participants. Thus, our original AHQ was indeed able to reproduce the results of our previous study (Hupfeld et al., 2019) in the MTurk cohort.

However, in the Subject Pool cohort, the ADHD and non-ADHD participants did not report significantly different HF scores (Figure 6). That is, on the AHQ, both groups reported similar HF experiences. Thus, the Subject Pool cohort did not replicate our previous findings of higher HF scores in those with ADHD. Although (as described above), we did not specifically recruit for people with and without ADHD diagnoses in this cohort, so the ADHD group was much smaller than the non-ADHD group in the Subject Pool cohort (n = 6 vs. n = 77). The small size of this ADHD group may have contributed to this unexpected finding.

AHQ-2 Dispositional HF Score for ADHD vs. Non-ADHD

Next, we examined AHQ-2 scores to determine if there was a significant difference in average dispositional AHQ-2 HF score between ADHD and non-ADHD participants within each cohort.

For the MTurk cohort, the results indicated a significantly different AHQ-2 dispositional HF score between the ADHD and non-ADHD groups ($p < .001$; Figure 7). Similarly, in the Subject Pool cohort, we also found a significantly higher AHQ-2 dispositional HF score in ADHD participants versus non-ADHD participants ($p = .05$; Figure 8). As with the AHQ, these AHQ-2 results replicate our past work (Hupfeld et al., 2019) and suggest that those with ADHD experience more frequent HF than their non-ADHD counterparts. Moreover, these results suggest that, as hypothesized, scores on our newly formed AHQ-2 scale also differ by ADHD diagnosis similar to our original AHQ scale.

Comparing AHQ and AHQ-2

In order to determine whether our newly formed scale, AHQ-2, measures the same construct as our original AHQ scale, we performed correlational analyses between participant scores on the two scales. We tested these relationships separately across the ADHD and non-

ADHD groups as well as across all combined participants within the two cohorts (MTurk and Subject Pool).

Within the MTurk cohort, ADHD subjects showed a significant moderate correlation between their AHQ and AHQ-2 HF scores ($r = .51$, $p < .001$; Figure 9). Similarly, non-ADHD subjects also showed a significant moderate correlation between their AHQ and AHQ-2 scores ($r = .69$, $p < .001$; Figure 10). Across all participants, we found an even stronger correlation between AHQ and AHQ-2 HF scores ($r = .71$, $p < .001$; Figure 11). These results suggest that, across our 100-person MTurk cohort, the AHQ and AHQ-2 do measure HF in the same way.

Correlational analyses indicated no significant correlation among the Subject Pool cohort between AHQ and AHQ-2 scores for the ADHD, non-ADHD, or the combined sample ($r = .11, .11, .12$; $p > .2, .2, .2$; Figures 12-14). These results suggest that the AHQ-2 is different from the AHQ. While these specific results do not support our hypothesis, there are several limitations to the Subject Pool cohort which we discuss in more detail below.

Comparing CAARS and AHQ

The purpose of administering the CAARS survey with our own questionnaires was to test whether the AHQ correlates with an already established ADHD scale and to test if HF correlates with ADHD symptom severity (as demonstrated in our previous work, Hupfeld et al., 2019). Correlational analyses were used to test for a relationship between AHQ and CAARS for ADHD, non-ADHD, and all participants across both participant cohorts (Figures 15-17).

Among the MTurk cohort, correlational analyses indicated a significant, moderate relationship between AHQ and CAARS symptom scores for the ADHD, non-ADHD, and combined cohorts ($r = .65, .66, .56$; $p < .01, .001, .001$; Figures 15-17). These findings replicate our previous results (Hupfeld et al., 2019), supporting that higher HF (measured with the original

AHQ) correlates with more severe ADHD symptoms (measured with the CAARS). This validates HF as a potential component of ADHD as CAARS is already an established questionnaire indexing ADHD symptoms.

Correlational analyses indicated that, for the Subject Pool cohort, there were no significant relationships between CAARS symptom scores and AHQ scores for the ADHD, non-ADHD, or combined cohorts (r = .45, .17, .17; p = .37, .14, .13; Figures 18-20). In contradiction with the MTurk population and with our past work (Hupfeld et al., 2019), this suggests that HF is not related to ADHD symptoms. However, limitations to the Subject Pool study, as mentioned previously, are outlined below.

Comparing CAARS and AHQ-2

We conducted the same correlational analyses with AHQ-2 scores to test whether our newly formed questionnaire correlated with CAARS ADHD symptom scores. The analysis was divided into the same three groups as before for each of the two cohorts: ADHD, non-ADHD, and all combined participants (Figures 21-26).

Correlational analyses indicated a significant, moderate association between CAARS and AHQ-2 scores within the ADHD and non-ADHD groups separately and across all participants (r = .59, .49, .56; p < .01, .001, .001; Figures 21-23). This suggests that, as anticipated, our new AHQ-2 scale replicates our past finding (Hupfeld et al., 2019) of higher HF correlating with more severe ADHD symptoms. This provides further support that HF as measured by the AHQ-2 relates to ADHD symptoms.

Correlational analyses revealed no significant relationship for the Subject Pool group between AHQ-2 dispositional HF scores and CAARS symptom scores for the ADHD, non-ADHD, or combined groups (r = .26, .086, .16; p = .62, .46, .15; Figures 24-26). This does not

support our hypothesis or the MTurk cohort finding that higher HF scores on our new AHQ-2 would correlate with higher ADHD symptom scores; however, as previously mentioned, we describe possible reasons for these Subject Pool findings below.

Positive and Negative HF in AHQ-2

Finally, as an exploratory aim of Study 3, we added new positive versus negative oriented questions in the AHQ-2 and tested for group differences in HF scores between these high and low HF groups to characterize any differences in positive and negative HF experiences between ADHD and non-ADHD participants. We evaluated the positive and negative HF score for the individuals who reported HF scores in the top 50% and the bottom 50% of the MTurk and Subject Pool cohorts. The top 50% of AHQ-2 HF scores was calculated by taking the highest possible AHQ-2 HF score divided by two (65/2 = 32.5). Those who had a total AHQ-2 HF score of greater than 32.5 were in the top 50%; anyone with a score lower than 32.5 were in the bottom 50%. Positive and negative items were selected from the AHQ-2 Dispositional Scale and the score for each was added for ADHD and non-ADHD participants separately.

These analyses indicate that there is a significant difference between responses to positive versus negative HF questions between the top and bottom 50% hyperfocused individuals for both the MTurk and Subject Pool samples ($p < .0001$, .0001; Figures 27-28). These results suggest that high hyperfocused individuals experience both more frequent positive and more frequent negative HF compared to low hyperfocused individuals.

General Discussion

The purpose of Study 1 was to examine the underlying cognitive mechanisms of HF in adults with and without ADHD. We predicted that adults with ADHD experience more HF than neurotypical individuals, which may make it more difficult for them to complete task-switching

tasks. Thus, we also predicted that adults with ADHD would have a slower reaction time than our non-ADHD control group. We tested this hypothesis by administering our original AHQ to index HF and then had participants complete a computerized task-switching task to measure reaction time. Switch and mixing costs were calculated to examine distractibility, which we hypothesized would be heightened in adults with ADHD.

The results from Study 1 revealed that participants who reported higher HF had lower switch costs than those who reported lower HF. This finding suggests that people with higher HF actually performed *better* than their counterparts on task-switching. We originally predicted that individuals with ADHD would have higher HF, and thus, would have higher switch costs because HF would increase their reaction time. However, this was not the case. A potential explanation for this result could be that HF on a task might actually motivate participants to do better at task-switching. That is, participants may have been hyperfocusing on the task-switching task, and thus performing better. Furthermore, while we found a slight negative relationship between HF score and mixing cost, this relationship was not significant. After comparing switch and mixing cost between ADHD and non-ADHD participants, we found that there was no significant difference between these groups. While we expected ADHD individuals to have a significantly higher switch and mixing cost, the data were not conclusive. Lastly, in Study 1, we also administered the Ozel-Kizil et al. (2016) HS to examine whether our AHQ correlated with this previously published HF scale. As the AHQ was created to test the same construct as the HS (except with more questions to more comprehensively index HF), we expected a significant correlation between the two scales. Indeed, we found participants' HF score on both scales did moderately correlate (p = .025). This suggests that our AHQ and the HS are both measuring a similar HF construct.

After completing our in-person Study 1, we decided that the AHQ was too long for practical academic and clinical use. We also realized that the AHQ never underwent a formal scale development process to ensure that the intended construct(s) were measured in the most accurate and straightforward way. Additionally, with the ongoing COVID-19 pandemic, we decided that continuing in-person data collection in the lab was not the most health-conscious idea. Thus, the purpose of Study 2 was to rewind and undergo a formal process where we determined what our scale would measure (HF), calculated the factor loadings for our preexisting questions, edited and revised questions based on those analyses, and administered cognitive interviews to better gauge the understanding and focus of our drafted questions. To begin, we ran two pilot cognitive interviews and collected qualitative data.

Based on these cognitive interviews, an emerging theme was that the answer choices did not fully encompass the participants' own HF experiences. According to both participants, HF might not be a daily occurrence, but of the times that HF does occur, perhaps only a certain amount of those times can it be described as HF. These interviews gave us valuable insight into parts of our questions that were confusing or ambiguous. Initially, we expected participants to express their concerns mainly on the specific wording of each item. However, the answer choices became the main focus of our edits and revision. Upon qualitative analysis, we proceeded to revise the questionnaire to form the AHQ-2 and to then administer this new AHQ-2 scale in Study 3. While we continued with Study 3 based on these preliminary data, our AHQ-2 cognitive interviews and scale revision processes are still ongoing.

The primary purpose of Study 3 was to take the revised AHQ-2 and measure its construct validity to examine whether it measures HF as we had intended. To do this, the administered questionnaire included the AHQ, AHQ-2, CAARS (to index ADHD symptoms), and a

demographics survey (including questions about any previous ADHD diagnoses). We collected two samples from two different populations: MTurk and the University of Michigan Introductory Psychology Subject Pool. Statistical analyses were performed separately for each cohort. We tested for correlations between AHQ and AHQ-2 scores to determine if our revised questionnaire still measured HF like we intended with AHQ. We also correlated AHQ and AHQ-2 scores with the existing CAARS survey to see if we could replicate our previous findings (Hupfeld et al., 2019) and find a similar relationship between higher HF and more ADHD symptoms with the new AHQ-2 scale.

Below, I discuss the results for the MTurk and Subject Pool cohorts separately. First, I compared the average HF score between the ADHD and non-ADHD participants from the AHQ. We expected individuals with ADHD to show significantly higher HF than those without ADHD. The MTurk results indicated that our original scale does, in fact, find higher HF for ADHD compared to non-ADHD adults. The Subject Pool results, however, did not show any significant difference in AHQ HF scores between ADHD and non-ADHD participants. Next, I used the same model to analyze the differences between AHQ-2 scores for ADHD and non-ADHD participants. Results from the MTurk group showed that again, ADHD individuals had significantly higher HF scores than non-ADHD adults. Similarly, the Subject Pool cohort also followed this trend. This suggests that the AHQ-2 did support our prediction that ADHD adults experience more HF than those without ADHD for both groups. More details on limitations of these results are discussed in the "Limitations and Future Directions" section below; however, it is important to note that if attention was a problem for the Subject Pool participants (e.g., as seven of these subjects failed attention checks, whereas none of the MTurk participants failed attention checks), then perhaps the AHQ-2 was better to administer to the Subject Pool group

since it was shorter and more concise. This could have then led to more accurate HF scores on the AHQ-2 for the Subject Pool subjects and thus supported our hypotheses.

Next, I compared the AHQ and AHQ-2 HF scores for correlational analysis. The purpose of this analysis was to test whether our revised AHQ-2 scale measured the same HF construct as our original AHQ scale. For both of the cohorts, I separated these analyses into 3 groups: ADHD, non-ADHD, and all participants. For the MTurk group, AHQ and AHQ-2 scores showed a significant, moderate correlation across all 3 groups. This suggests that AHQ-2 does measure HF in the same way as the AHQ and suggests that our scale development processes were successful. With these significant correlations, the AHQ-2 may be ready for use (as opposed to the AHQ) as a concise scale for measuring HF and as a clinical aid in ADHD diagnosis. When looking at the Subject Pool data, however, there was no significant correlation between AHQ and AHQ-2 for any of the three groups. Again (as discussed in the "Limitations and Future Directions"), if paying adequate attention to the questionnaire items was a problem for the Subject Pool sample, perhaps their scores for the original AHQ were not accurate because the original AHQ was too long and wordy. Consequently, there was then no correlation between AHQ and AHQ-2 scores for the Subject Pool cohort.

I also compared CAARS with AHQ and AHQ-2 for the three groups (ADHD, non-ADHD, all) across both cohorts to determine if the two scales we created correlate to an already established ADHD scale. The MTurk data showed a significant and moderately strong correlation between CAARS and AHQ for all three groups. Likewise, CAARS and AHQ-2 data showed similar correlations which supports that HF is correlated with ADHD symptoms. This suggests that the AHQ-2 is a good predictor of ADHD. The Subject Pool data show no significant correlations between CAARS and AHQ or CAARS and AHQ-2 which suggests that

AHQ-2 might not be a good indicator of ADHD. It is important to note, however, that the Subject Pool data only had six ADHD participants, and many were excluded which serves as a limitation that will be discussed more down below.

Finally, we wanted to inspect the positive and negative characteristics of HF. Conner (1994) wrote that HF may be a normal occurrence for many people, but it tends to occur more in those diagnosed with ADHD. Thus, we included questions in the AHQ-2 that specifically were framed in a more positive or negative manner to explore these aspects. Because both the Ozel-Kizil (2016) HS and the original AHQ contained mostly negative items, one might conclude that HF is a negative trait in people with ADHD which, of note, may correspond to things like internet addiction which is also higher in adults with ADHD (Yen et al., 2009). However, adding positive questions and then testing to see if people high in HF also report high *positive* HF suggests that HF may have both positive and negative facets. The results supported this hypothesis and revealed that high-hyperfocused individuals experience more positive and more negative hyperfocus than their less-hyperfocused counterparts for both the MTurk and Subject Pool cohorts. This ultimately shows that HF can be a positive trait among those with ADHD.

Implications for Society

Currently, there are only a few published tools that thoroughly measure HF. One scale that has already been published is the HS created by Turkish researchers Ozel-Kizil et al. (2016). While that scale is the first of its kind, it was originally written and administered in Turkish and has many limitations to its use. Therefore, while developing the AHQ and redeveloping the AHQ into AHQ-2, we kept in mind how this scale could be among the first few instruments that could be used widely in professional and clinical settings to help with understanding HF in ADHD and possibly with diagnosis of adult ADHD.

On this note, our findings suggest that HF could be a characteristic of ADHD. However, in the current clinical literature and in the Diagnostic and Statistical Manual of Mental Disorders, 5th Edition (DSM-V), HF is not considered an official symptom for ADHD diagnosis (American Psychiatric Association, 2013). Perhaps with further development and refinement of the scale, changes can be made to the DSM-V to encompass the HF experiences of some individuals with ADHD.

On a societal level, many people tend to buy into the stereotype that ADHD is an attention-*deficit* disorder in which people with ADHD simply cannot focus on any one thing or cannot "slow down" in their life. This stereotype against people with ADHD contributes to the widespread stigma surrounding attention incapability. However, our research shows that the ADHD population is not a monolith, and that ADHD can manifest differently in different people. Perhaps, adults with ADHD encounter a form of attention dysregulation that may generate excessive focus and long periods of HF, but the effects are not always negative. Anecdotally, many people with ADHD report HF to be a strength which allows them to complete complicated or arduous tasks. Our research demonstrates that ADHD could be less of a deficit and more of a strength. This research could shift the focus of school curriculums and workplace environments to accommodate for the different ways ADHD affects individuals. For example, perhaps teachers could develop lesson plans that specifically address the concept of HF to help students with ADHD better regulate their attention. This could also lead to implications in society on a widespread level in public policy and healthcare to ensure the inclusivity of the broad spectrum of ADHD.

Limitations and Future Directions

An important limitation to our study was our sample size. For Study 1, the sample size was small for both the control (n = 19) and ADHD group (n = 11). While the cognitive interview data collection is still ongoing in Study 2, the sample we have collected to date was too small to accurately and holistically review the ambiguities in our questions. Additionally, in Study 3, our ADHD sample size was small. We did not specifically recruit for ADHD participants, so our sample size was limited to only 16 ADHD MTurk participants and six ADHD Subject Pool participants. Perhaps with a better powered ADHD group, we would have found significant group differences on the AHQ. Furthermore, seven participants were excluded from the Subject Pool cohort because they did not pass the attention checks while no participants were removed from the MTurk cohort due to failing the attention checks. When examining the duration of time spent completing our study, many Subject Pool participants perhaps did not spend enough time answering the questionnaire items; for example, many Subject Pool participants spent less than 15 minutes on the AHQ-2 when the allotted time for this questionnaire was 30 minutes. Considering that the Subject Pool group comprises of undergraduate college students, their performance could be due in part to Zoom fatigue resulting from the COVID-19 pandemic. This thus suggests that the Subject Pool sample was not the best for a virtual survey. In the future, post-COVID, it would be more useful to bring Subject Pool participants into the lab for these surveys to ensure that there are no distractions.

In Study 1, we collected data on the medications our ADHD participants were currently taking or have taken in the past. In the future, it would be useful to investigate the effects of different medications and how the duration of medication use may influence HF scores and one's ability to HF on task performance. Perhaps those who are currently taking medication for ADHD can better control their focus which would, in turn, affect their task performance. It would also

be useful to correlate the self-reported HF scores with CPT reaction times to more comprehensively characterize any differences in task performance between ADHD and non-ADHD adults.

As we continue our data collection, the revision process of the AHQ-2 shortened scale will continue. While these preliminary data look promising, it will be useful to obtain more cognitive interviews and perform further analyses (e.g., another EFA and IRT on these revised questions) to gain additional quantitative data regarding which questions should or should not be included in the final update to the scale.

While our current study focuses on how ADHD manifests in adults, we plan to use our finalized scale to create an HF scale for children in the future. In 2011, the prevalence of ADHD in children was 11.0% which is much higher than the prevalence of ADHD in adults (4.4%) (National Institute of Mental Health, 2017). A HF scale for children could be useful not only in clinically diagnosing ADHD, but also in providing a strengths-based early intervention to help children with ADHD direct their abilities to intensely focus on productive outlets at home and in school.

Additionally, with the COVID-19 pandemic, it was difficult to return to the lab for in-person data collection. Therefore, many of the portions that we wished to continue from Study 1, such as continuing task-switching data collection, had to be halted. Thus, it is important to note the impact of the COVID-19 pandemic on both in-person and virtual data collection for the researchers and our participants.

Conclusion

In summary, we replicated Hupfeld et al. (2019) in finding that ADHD adults experience more hyperfocus. In Study 1, we did not find evidence to support that higher HF would be

related to slower reaction time during task-switching tasks. In fact, those who reported higher HF had a *faster* reaction time during the task-switching task. Due to the COVID-19 pandemic halting in-person data collection, and because our original AHQ scale was too long for practical use, Study 2 identified appropriate questions to test for a shortened HF scale. In Study 2, the preliminary data suggested that we needed to revise our scale's answer choices, which led us to Study 3. After revising and reordering the questionnaire and administering this AHQ-2 to two different samples, we found that HF is more prevalent in our ADHD population than our non-ADHD population. Additionally, we found that ADHD adults experience more positive and more negative characteristics of HF than their non-ADHD counterparts. While these data collected to date are promising, the shortened scale is not yet finalized and requires further rounds of development, revision, and analyses before presenting it to the public for professional use. We hope that with continued research, the AHQ-2 can aid in the clinical diagnosis of ADHD as well as provide schools, parents, and community members with a resource to better navigate the patterns and effects of ADHD.

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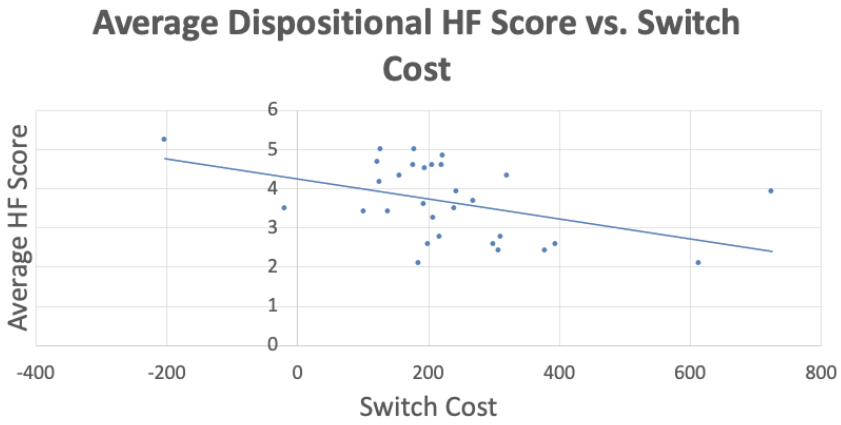
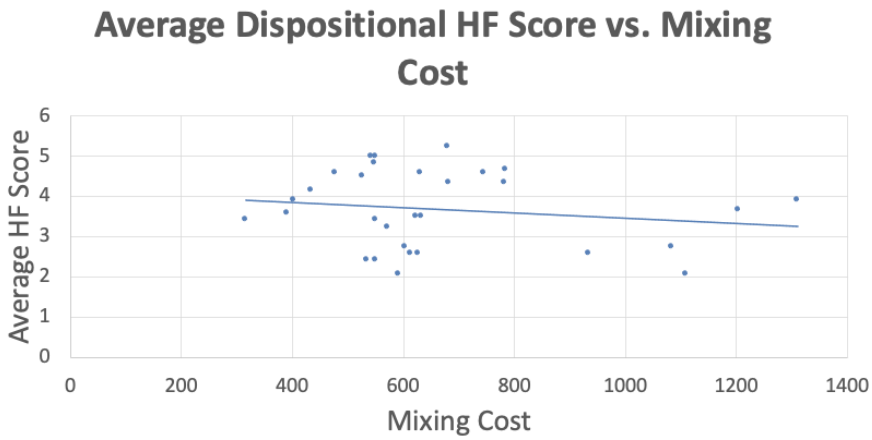
Figure 1



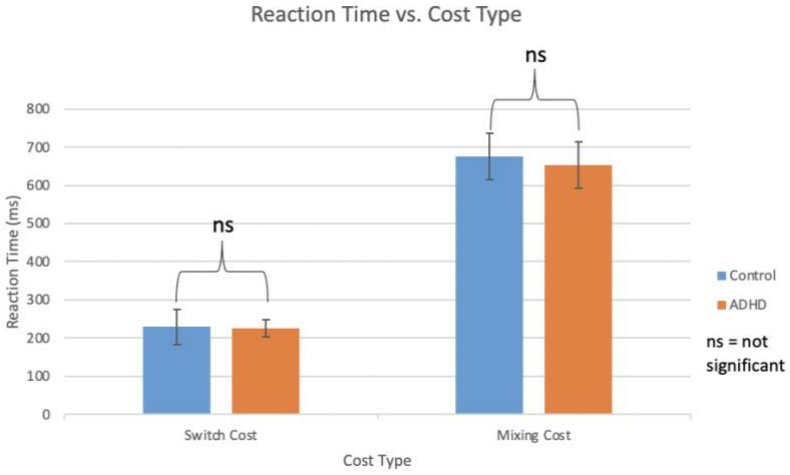
Note. r = -.44, p = .015. Average Dispositional HF Score vs. Switch Cost (Study 1). Results indicate that there is a significant negative correlation between HF Score and Switch Cost (higher HF = lower switch cost).

Figure 2



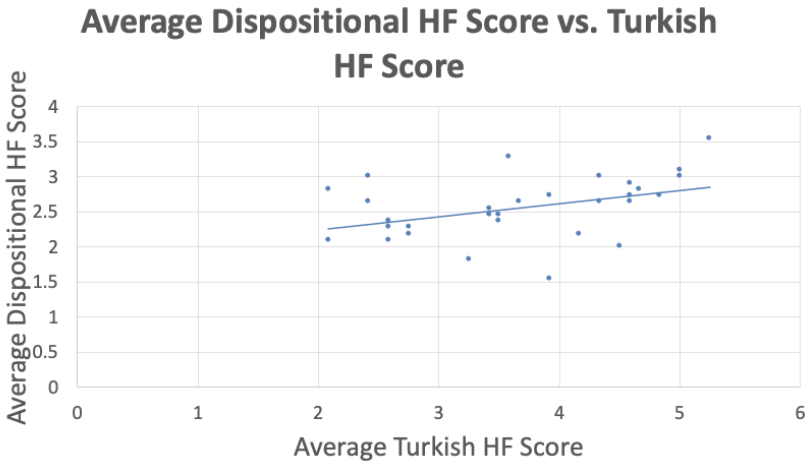
Note. r = -.164, p = .39. Average Dispositional HF Score vs. Mixing Cost (Study 1). Results show a weak, but non-significant negative relationship between HF score and mixing cost.

Figure 3



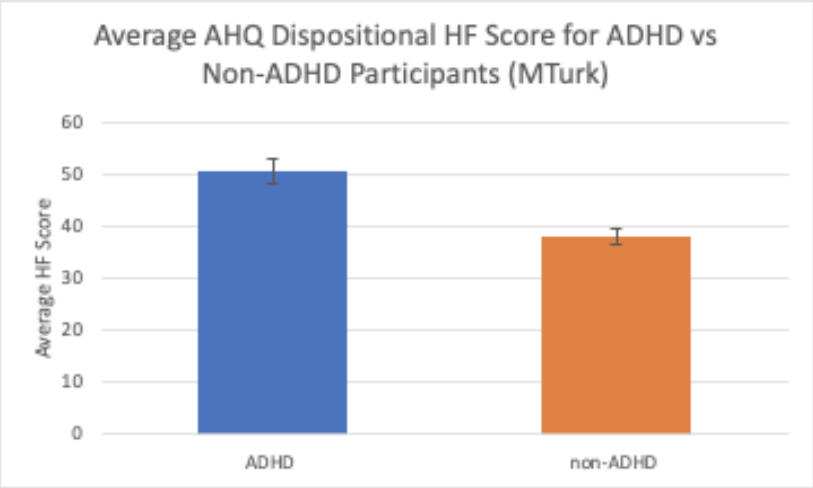
Note. p = .80 (switch cost); p = .95 (mixing cost). Average reaction time (ms) vs. Cost Type for ADHD and Control (non-ADHD) groups (Study 1). No significance was observed between ADHD and non-ADHD groups.

Figure 4



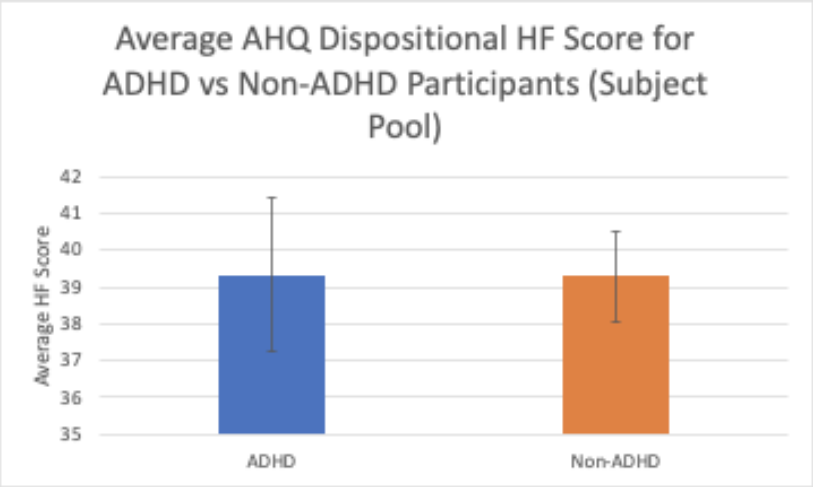
Note. r = .41, p = .025. Average Dispositional HF Score (AHQ) vs. Ozel-Kizil HS Score (Study 1). Results indicate that there is a significant positive correlation between AHQ Dispositional HF Score and HS score.

Figure 5



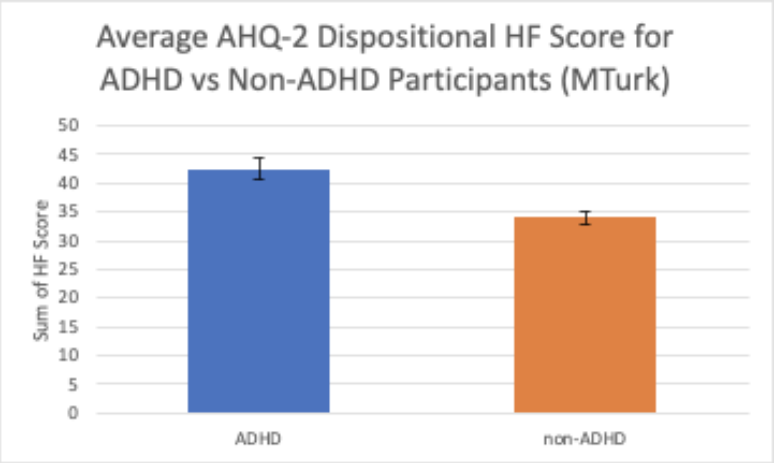
Note. $p < .001$. Average AHQ Dispositional HF Score for ADHD vs. Non-ADHD Participants on MTurk (Study 3). Results indicate a significant difference in AHQ HF score between those with and without ADHD.

Figure 6



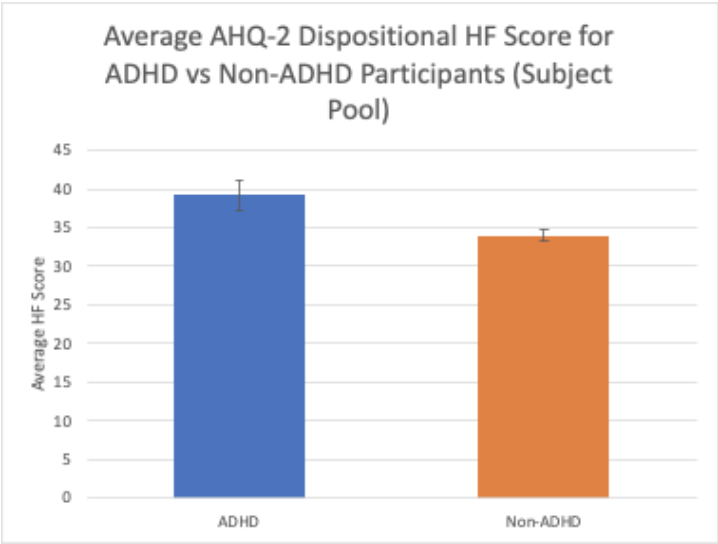
Note. $p = .99$. Average AHQ Dispositional HF Score for ADHD vs. Non-ADHD Participants in the Subject Pool Cohort (Study 3). Results show no significant difference in AHQ HF score between ADHD and non-ADHD participants.

Figure 7



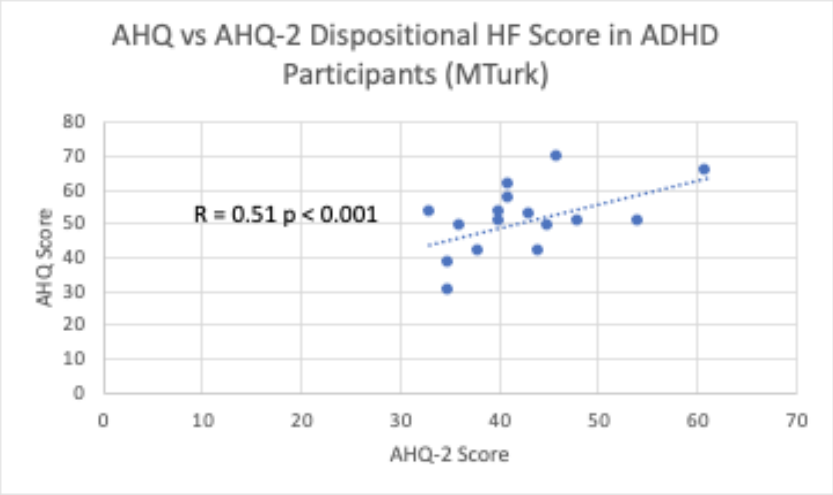
Note. $p < .001$. Average AHQ-2 Dispositional HF Score between ADHD and Non-ADHD Participants from the MTurk cohort (Study 3). Results indicate a significantly higher AHQ-2 HF score for ADHD than non-ADHD subjects.

Figure 8



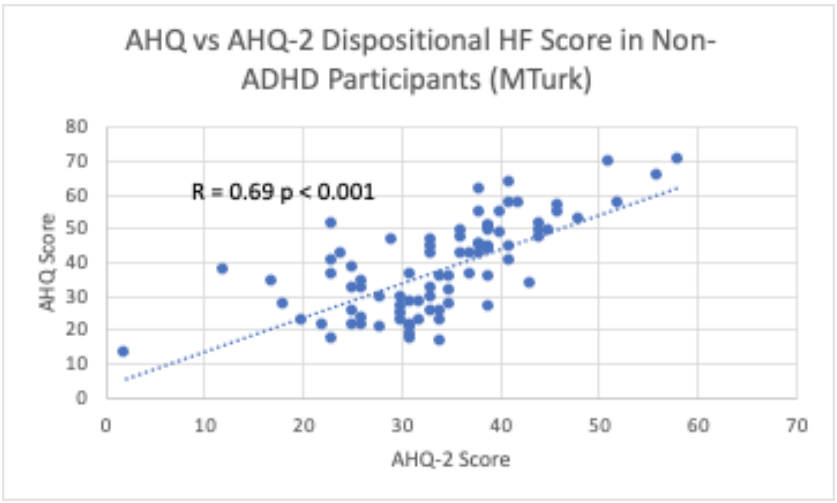
Note. $p = .05$. Average AHQ-2 Dispositional HF Score for ADHD vs. Non-ADHD Subject Pool Participants (Study 3). Results show a significantly higher AHQ-2 HF score for ADHD compared to non-ADHD subjects.

Figure 9



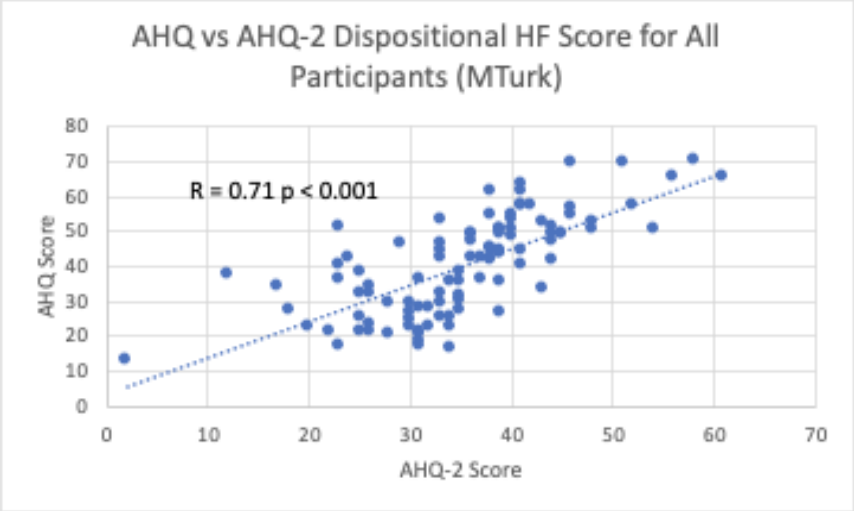
Note. $r = .51$, $p < .001$. AHQ vs. AHQ-2 Dispositional HF Score for ADHD MTurk Participants (Study 3). There is a significant correlation between AHQ and AHQ-2 scores for those with ADHD.

Figure 10



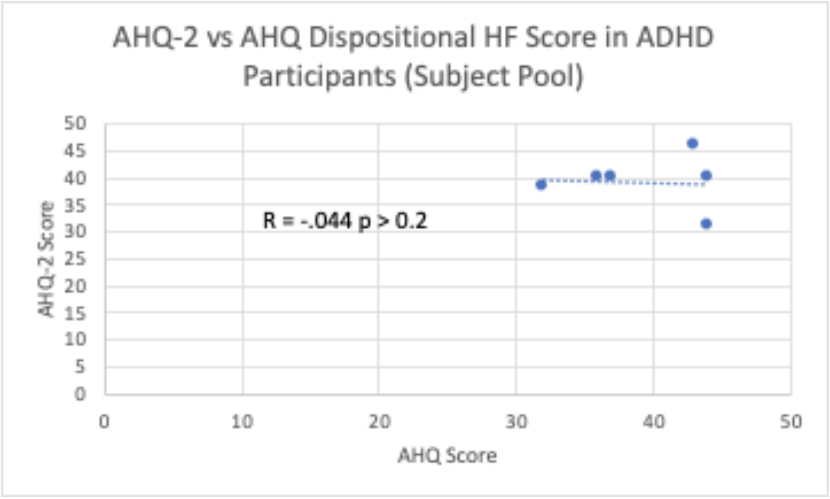
Note. $r = .69$, $p < .001$. AHQ vs. AHQ-2 Dispositional HF Score in Non-ADHD MTurk Participants (Study 3). There is significant correlation between AHQ and AHQ-2 for those without ADHD.

Figure 11



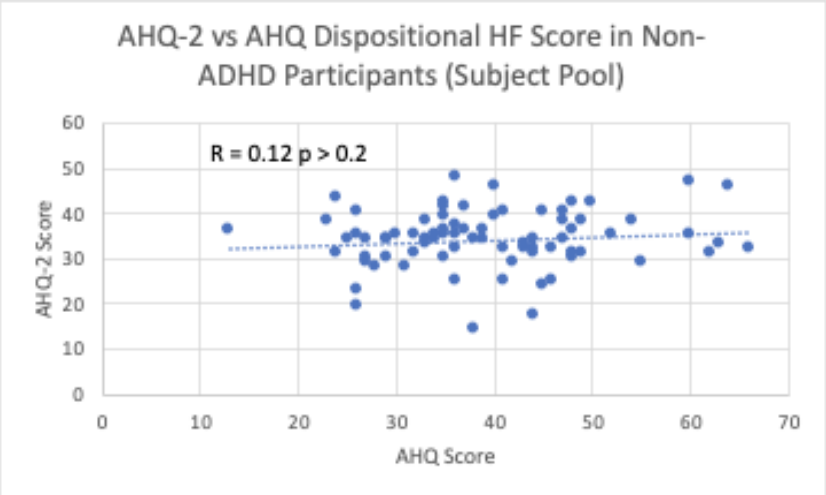
Note. $r = .71$, $p < .001$. AHQ vs. AHQ-2 Dispositional HF Score for All MTurk Participants (Study 3). Results indicate a significant correlation between AHQ and AHQ-2 across all MTurk participants.

Figure 12



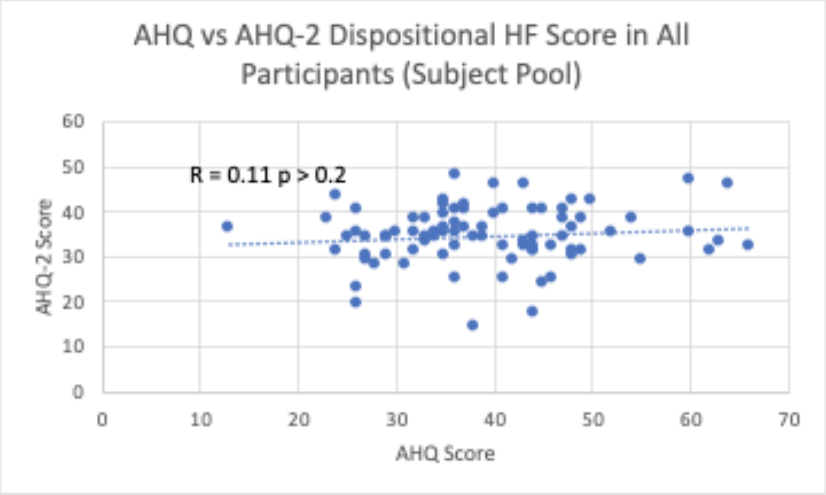
Note. $r = -.044$, $p > .2$. AHQ-2 vs. AHQ Dispositional HF Score in Subject Pool ADHD Participants (Study 3). Results indicate no significant correlation between AHQ-2 and AHQ scores for people with ADHD in this cohort.

Figure 13



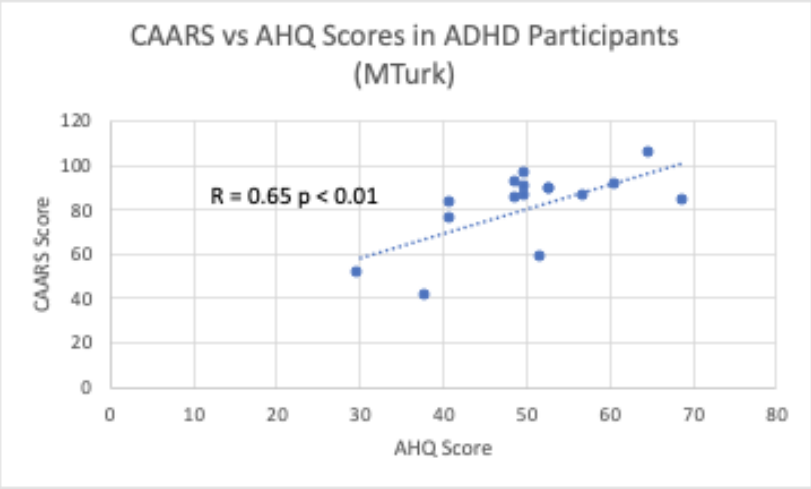
Note. $r = .12$, $p > .2$. AHQ-2 vs. AHQ Dispositional HF Score in Subject Pool Non-ADHD Participants (Study 3). Results indicate no significant correlation between AHQ-2 and AHQ scores for people without ADHD in this cohort.

Figure 14



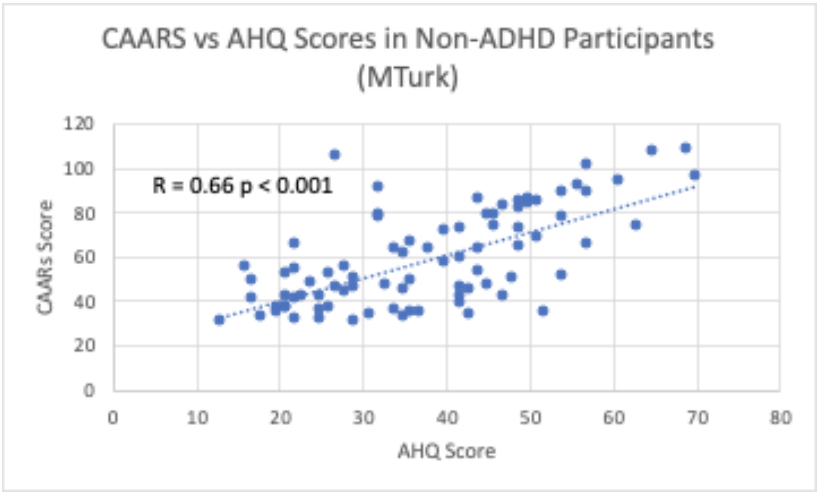
Note. $r = .11$, $p > .2$. CAARS vs. AHQ Scores in All Subject Pool Participants (Study 3). Results indicate there is no significant correlation between CAARS and AHQ for all participants combined.

Figure 15



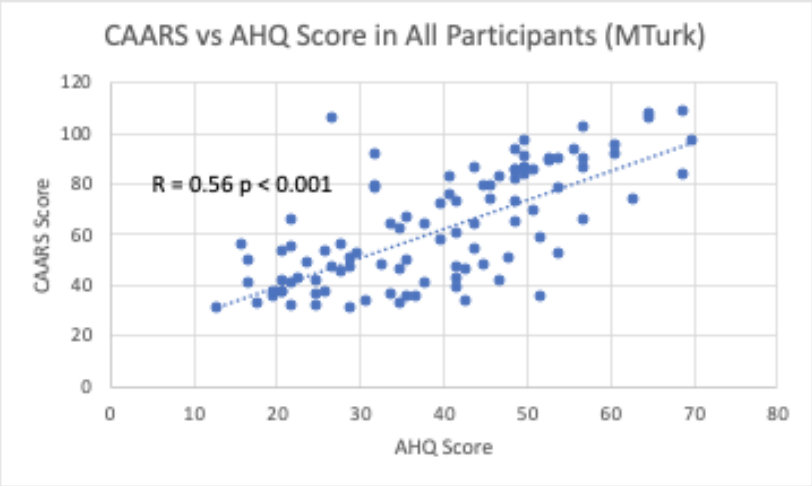
Note. $r = .65$, $p < .01$. CAARS vs. AHQ Scores in ADHD MTurk Participants (Study 3). There was a significant, moderate correlation between CAARS and AHQ for the ADHD subjects.

Figure 16



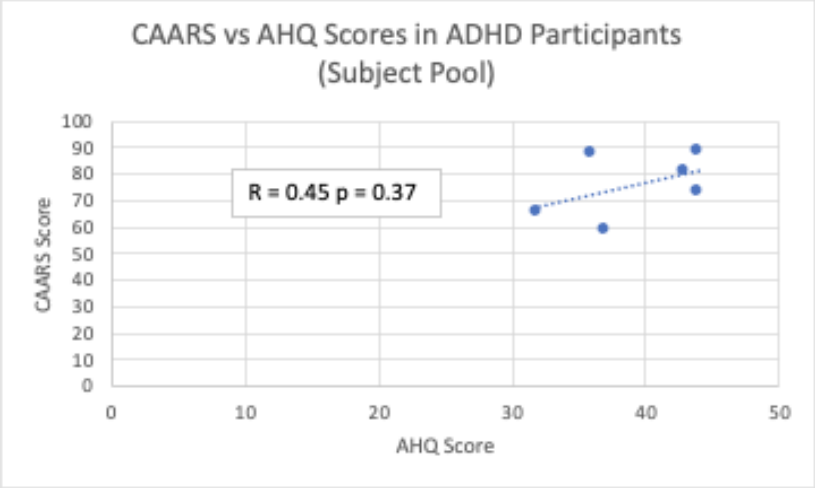
Note. $r = .66$, $p < .001$. CAARS vs. AHQ Scores in Non-ADHD MTurk Participants (Study 3). Results indicate significant moderately strong association between CAARS and AHQ for non-ADHD participants.

Figure 17



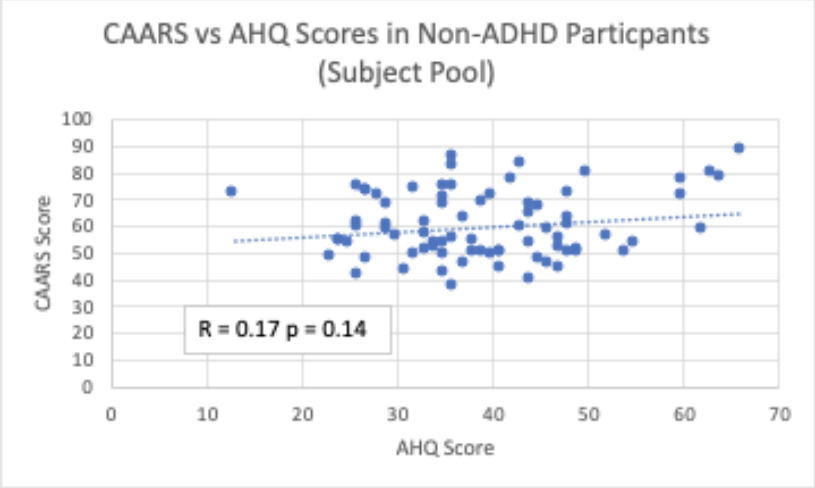
Note. $r = .56$, $p < .001$. CAARS vs. AHQ Score in All MTurk Participants (Study 3). There is a significantly moderate association between CAARS and AHQ for all participants combined.

Figure 18



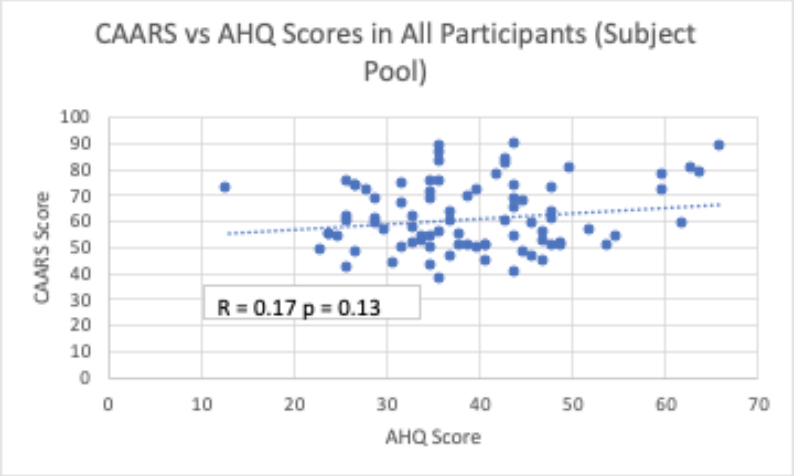
Note. $r = .45$, $p = .37$. CAARS vs. AHQ Scores in ADHD Subject Pool Participants (Study 3). There was no significant correlation between CAARS and AHQ scores for subjects with ADHD.

Figure 19



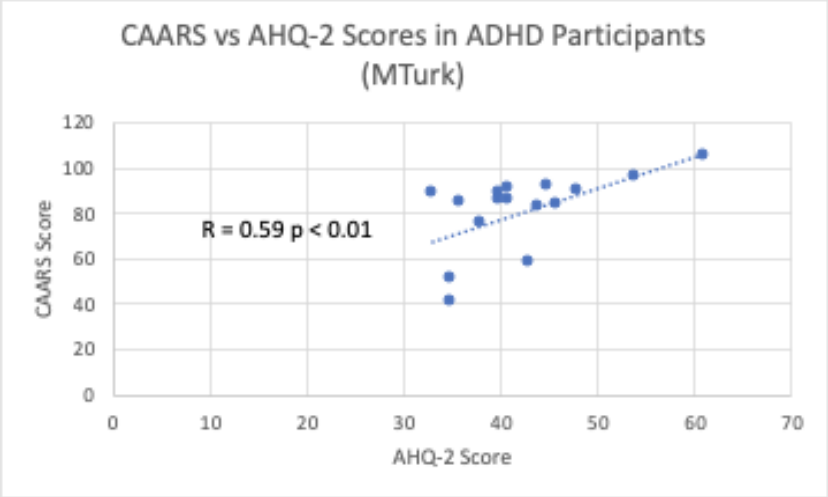
Note. r = .17, p = .14. CAARS vs. AHQ Scores in Non-ADHD Subject Pool Participants (Study 3). There was no significant correlation between CAARS and AHQ for non-ADHD participants.

Figure 20



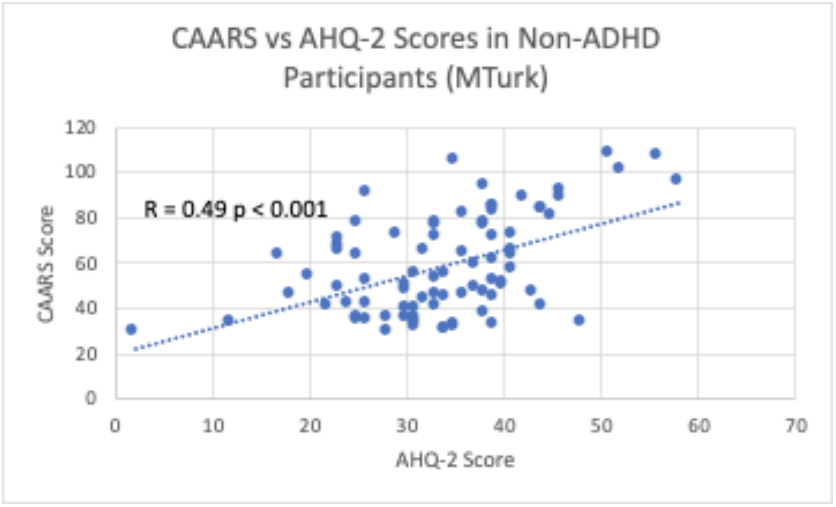
Note. r = .17, p = .13. CAARS vs. AHQ Scores in All Subject Pool Participants (Study 3). There was no significant correlation between CAARS and AHQ for all participants combined.

Figure 21



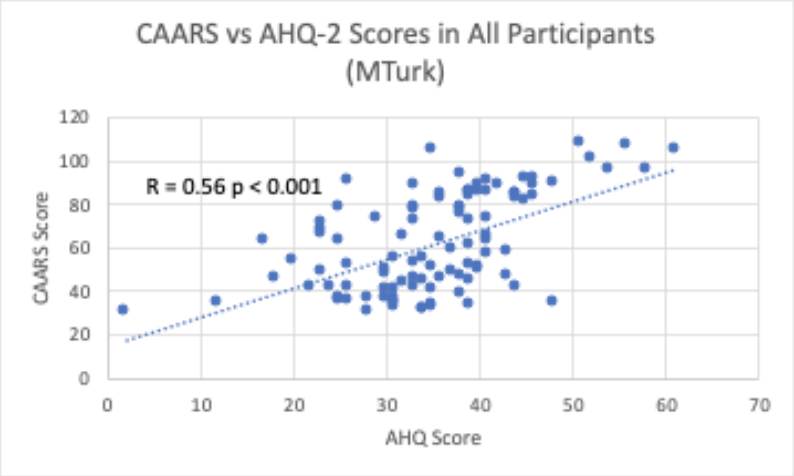
Note. $r = .59$, $p < .01$. CAARS vs. AHQ-2 Scores in MTurk ADHD Participants (Study 3). There was a significant moderate correlation between CAARS and AHQ-2 for participants with ADHD.

Figure 22



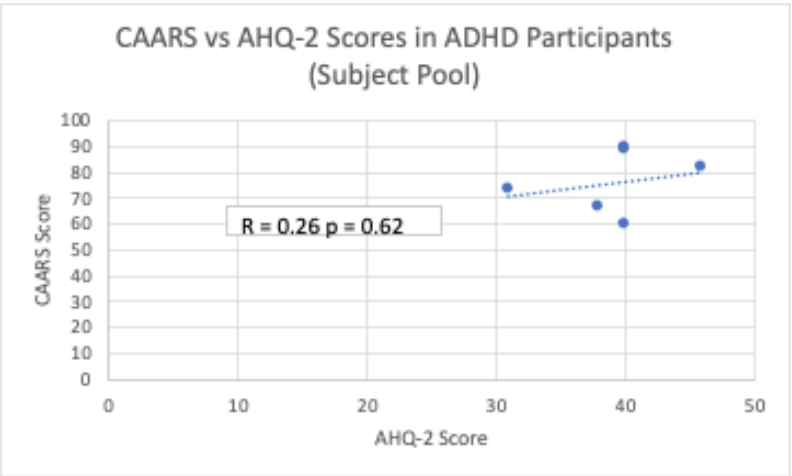
Note. $r = .49$, $p < .001$. CAARS vs. AHQ-2 Scores in MTurk Non-ADHD Participants (Study 3). There is a significant moderate correlation between CAARS and AHQ-2 in the non-ADHD cohort.

Figure 23



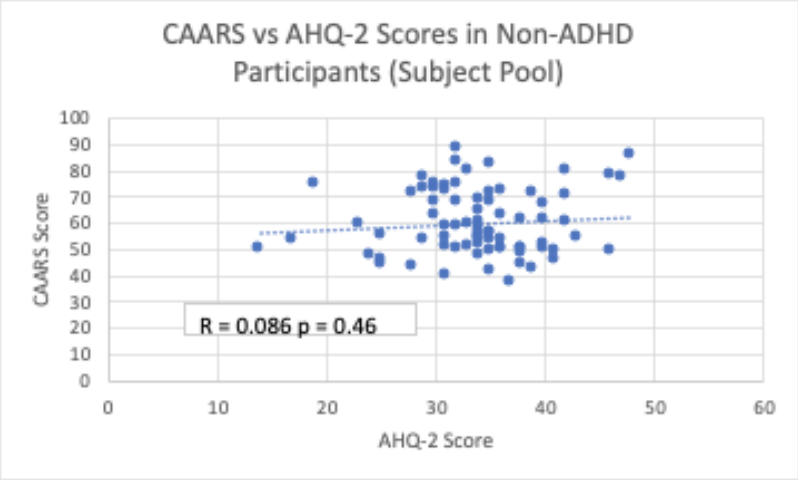
Note. r = .56, p < .001. CAARS vs. AHQ-2 Scores in All MTurk Participants (Study 3). MTurk cohort results indicated a significant, moderate correlation between CAARS and AHQ-2 for all participants combined.

Figure 24



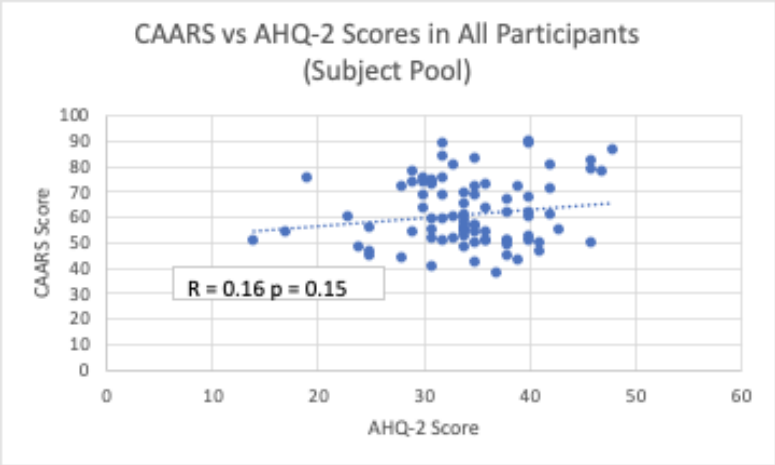
Note. r = .26, p = .62. CAARS vs. AHQ-2 Scores for ADHD Subject Pool Participants (Study 3). No significant correlation between CAARS and AHQ-2 for ADHD participants.

Figure 25



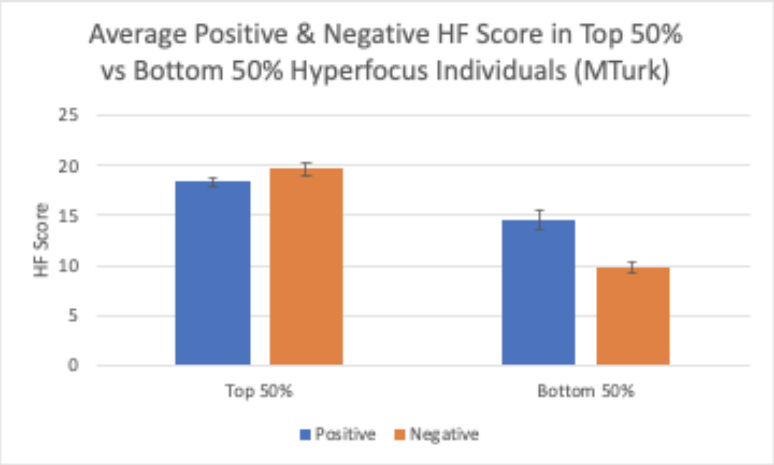
Note. r = .086, p = .46. CAARS vs. AHQ-2 Scores in Non-ADHD Subject Pool Participants (Study 3). No significant correlation between CAARS and AHQ-2 for non-ADHD subjects.

Figure 26



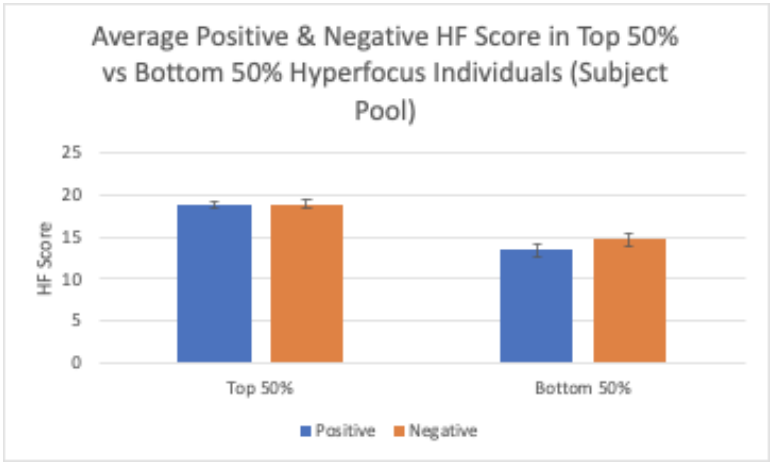
Note. r = .16, p = .15. CAARS vs. AHQ-2 Scores for All Subject Pool Participants (Study 3). No significant correlation between CAARS and AHQ-2 for all participants combined.

Figure 27



Note. $p < .0001$ (positive), $p < .0001$ (negative). Average Positive and Negative HF Score in Top 50% vs. Bottom 50% of MTurk HF Individuals (Study 3). There was a significant difference between positive and negative HF responses for the top and bottom 50% hyperfocused individuals.

Figure 28



Note. $p < .0001$ (positive), $p < .0001$ (negative). Average Positive and Negative HF Score in Top 50% vs. Bottom 50% of Subject Pool Hyperfocus Individuals (Study 3). There is a significant difference between positive and negative HF for the top and bottom 50% of hyperfocused individuals.

Appendix A

Low loading questions in both dispositional and scenario questionnaire subsections based on IRT and EFA analysis.

Dispositional Questions:

1) Generally, when I am busy doing something I enjoy or something that I am very focused on, I tend to completely lose track of the time.
2) In general, when I am very focused on something or I am doing something that I find especially rewarding, I do not notice the world around me, and I won't realize if someone calls my name or if my phone buzzes.
3) Generally, when I am very focused on something or doing something that I find especially rewarding, I might accidentally miss meals, stay up all night, or keep doing the activity until I absolutely must get up to go to the bathroom.
4) In general, when I am busy doing something I enjoy or something that I am very focused on, I find it very difficult to quit and move on to doing something else, even if I have a lot of other important things I should be doing instead.
5) Generally, when I am very focused on something or doing something that I find especially rewarding, I can feel totally captivated by or "hooked" on the activity.
6) Generally, when I am very focused on something or doing something that I find especially rewarding, I feel like I can't stop doing the activity, even if I have other more important responsibilities.

Scenario Questions:

1) “If I’m looking at clothes online or Pinterest ideas for new projects I want to do, I will sometimes get up from my chair and be very stiff, realizing that I haven’t shifted positions in hours.”
2) “When I’m working on motorcycles, I forget the world. I have a rush from how driving fast makes me feel, so I associate that with working on motorcycles. My mind just goes crazy, on ‘overdrive,’ and I can’t think of anything else. I’ll be in class and thinking about the details of how to wire my motorcycle. When I get into a project I really enjoy, I ‘go all out’ until I burn out.”
3) “When I’m shopping online for something—even just a new pair of running shoes—I can spend hours on my computer searching for the ‘perfect’ choice. I’ll search through website after website looking for the best deal, perfect color, coolest brand, and so on, and then I’ll read through as many reviews as I possibly can until I’m fully satisfied that I’ve found the best option.”
4) “I get hooked on Netflix very easily and find that I cannot stop easily to get my homework done.”
5) “I can play videogames for hours at a time without moving. I get so focused on the screen. When I’m playing videogames, my roommates say that the only way they can get my attention is to jump in my face or if they turn the TV off.”
6) “When I’m on the Internet, it’s almost like I’m under a hypnotic spell. I’ll check my email, respond to Facebook messages, go through friends’ pictures, read some news articles, update my other social media pages…it just goes on and on, and sometimes I can’t control it. I tune out the world and immerse myself in the Internet, even when I know that I’m not doing anything that meaningful online.”

7) “If I get on the Internet—especially looking at things like Buzzfeed, Facebook, or Pinterest—I’ll always think that it’s only been a few minutes, but then I’ll see the time and realize I’ve been online for an hour or two.”

Appendix B

Adult Hyperfocus Questionnaire-2 (AHQ-2) Draft

Please use the space provided to answer the following questions. Please provide as much detail as you can.

1) What types of activities usually cause you to become very focused (e.g., work for school or your job, a hobby, watching TV)? List as many activities as you can.
2) Please describe a time in the last year when you felt very focused on something.
3) How long did this episode of focus last?
4) How did you feel during this episode of focus?
5) Did you accomplish something in the end (e.g., a school or work assignment, a piece of artwork, or another type of project)?

These statements discuss feelings and experiences that might occur when people are deeply focused on activities (e.g., a hobby that they enjoy, or an important task for work or school). Please read each item carefully. Then, rate how often you had each feeling or experience <u>in the last year</u>.

Responses: Measured using 6-point Likert scale (1 = never, 6 = daily).

When I am busy doing something that I am very focused on:

1) I spend far too long on a small detail of the task and avoid other more important parts.
2) I am unsure of how much time has passed.
3) I am unaware of what time it is.
4) I don’t notice any distractions (e.g., if someone talks to me).
5) My mind does not wander.

6) I forget to attend to my personal needs (e.g., I forget to sleep or eat or I wait until the last minute to go to the bathroom).
7) I enjoy how captivated I become when doing the activity.
8) I do not like how fixated I am on the activity.
9) My ability to intensely focus helps me complete the activity.
10) I can be very productive.
11) I feel accomplished.
12) I generate creative solutions or ideas.
13) I find that I have wasted a great deal of time.

The next four questions ask about whether you consider your intense focus on certain tasks to be negative or positive.

Responses: Measured using 5-point Likert scale (1 = very negative, 5 = very positive).

1) In general, I consider my intense focus on tasks or activities to be or In general, I consider my experiences of focusing intensely on tasks or activities to be: (both were asked to see which one made more sense)
2) When studying for a class or doing work related to my job, I consider my intense focus on tasks or activities to be:
3) When doing activities related to my favorite hobby (e.g., practicing an instrument, playing a sport making art, or reading for fun), I consider my intense focus on tasks or activities to be:
4) When doing activities related to my favorite screen time activity (e.g., watching TV, playing video games, online shopping, or using social media), I consider my intense focus on tasks or activities to be:

Appendix C

Adult Hyperfocus Questionnaire 2 (AHQ-2) Final

Dispositional HF Questions:

This questionnaire asks about how you would characterize your focus in contexts that are engaging to you, whether it's reading a book, enjoying a hobby, playing a video game, working, or studying.

Responses: Measured using 6-point Likert scale (0 = never, 5 = always).

1) I spend far too long on small details of the task and avoid other more important parts.
2) I am unsure of how much time has passed.
3) I am unaware of what time it is because I am so focused on the activity.
4) I don't notice any distractions (e.g., if someone talks to me).
5) My mind does not wander.
6) I forget to attend to my personal needs (e.g., I forget to sleep or eat or I wait until the last minute to go to the bathroom).
7) I enjoy how captivated I become when doing the activity.
8) I do not like how fixated I am on the activity.
9) My ability to intensely focus helps me complete the activity.
10) I can be very productive.
11) I feel accomplished.
12) I generate creative solutions or ideas.
13) I find that I have wasted a great deal of time.

Positive & Negative Questions:

The next four questions ask about whether you consider your intense focus on certain tasks to be negative or positive.

Responses: Measured using 5-point Likert scale (1 = very negative, 5 = very positive).

1) In general, I consider my experiences of focusing intensely on tasks or activities to be:
2) When studying for a class or doing work related to my job, I consider my intense focus on tasks or activities to be:
3) When doing activities related to my favorite hobby (e.g., practicing an instrument, playing a sport making art, or reading for fun), I consider my intense focus on tasks or activities to be:
4) When doing activities related to my favorite screen time activity (e.g., watching TV, playing video games, online shopping, or using social media), I consider my intense focus on tasks or activities to be:

Open-ended Questions:

Please use the space provided to answer the following questions. Please provide as much detail as you can.

1) What types of activities usually cause you to become very focused (e.g., work for school or your job, a hobby, watching TV)? List as many activities as you can.
2) Please describe a time in the last year when you felt very focused on something.
3) How long did this episode of focus last?
4) How did you feel during this episode of focus?
5) Did you accomplish something in the end (e.g., a school or work assignment, a piece of artwork, or another type of project)?