Supplemental Information

Section 1. Description of samples and identification procedures

Initial screening of the unselected sample

An unselected sample of 3,913 undergraduates completed a battery of self-report rating scales that included the Self-Report form of the *ADHD Current and Childhood Symptom Scales* (1). The initial screening measures were administered to groups of 20-40 individuals as part of the research participation requirement of a large introductory psychology course. Permission was also requested to allow us to send the *Other Report* version of the *Current and Childhood Symptom Scales* (1) to the participant's parent or other primary caregiver during childhood. Approximately 72% of the participants provided consent for the questionnaire to be sent to their parent or caregiver.

Individual assessment of groups with and without DSM-IV ADHD

As part of an ongoing study of neuropsychological functioning in young adults with ADHD, a subset of participants from the initial screening sample were invited to participate in a more extensive individual testing session that included measures of general intelligence, academic achievement, and neuropsychological functioning. Participants who met symptom criteria for any DSM-IV ADHD subtype based on parent or self-report ratings on the *Current and Childhood Symptom Scales* were invited to complete the individual testing session (N = 207). In addition, a comparison sample without ADHD (N = 98) was randomly selected from the remainder of the screening sample and invited to participate in the individual assessment.

Identification of groups with and without DSM-IV ADHD combined type

Diagnostic algorithm for the combined type. At the conclusion of the individual assessment session, participants who met criteria for DSM-IV ADHD - combined type and who met all inclusion

criteria for the MR protocol were invited to participate in the fMRI study, and twenty individuals with ADHD were included in these analyses. The diagnosis of the combined type in adulthood is complicated by the fact that symptoms of ADHD decline with increasing age, particularly on measures of hyperactivity-impulsivity (e.g., 2-4). Therefore, four criteria were used to operationally define participants with the combined type for the fMRI study: (1) Retrospective reports by the participant or the parent indicated that he or she met DSM-IV criteria for the combined type during childhood; (2) the participant either currently met criteria for DSM-IV ADHD (N = 18) or scored above the 90th percentile on the ADHD symptom measures while exhibiting marked functional impairment, consistent with the DSM-IV specification of ADHD in partial remission (N = 2); (3) the ADHD symptoms led to significant functional impairment; and, (4) the onset of the ADHD symptoms was prior to 12 years of age. Although this age-of-onset criterion is slightly more liberal than the DSM-IV criterion specifying onset of impairment prior to age 7, it has been used by other studies of ADHD in both children and adults due to increasing evidence that it may be more reliable and valid than the threshold specified in DSM-IV (e.g., 5, 6).

Criteria for the comparison group. The comparison group for the fMRI study included 23 individuals who did not meet current or lifetime criteria for any DSM-IV ADHD subtype based on the rating scales and diagnostic interview. The control and ADHD samples were matched as a group on age, sex, and academic year.

Exclusion criteria. Potential participants were excluded from both groups if they reported a previous diagnosis of a learning disability (LD) or met our study criteria for an LD on the measures of reading or math achievement described below. Individuals with bipolar disorder, severe major depressive disorder, obsessive-compulsive disorder, or substance-use disorder were also excluded, as were potential participants who had an estimated Full Scale IQ < 80, were pregnant, were left

handed, had metal in their body that could not be removed (e.g., cardiac pacemaker), had a previous history of seizures or a head injury with loss of consciousness, or any other contraindication for the MR environment.

Measures

DSM-IV ADHD symptoms

Screening questionnaires. The unselected sample of 3,913 undergraduates completed a battery of self-report rating scales that included the Self-Report form of the *ADHD Current and Childhood Symptom Scales* (1). On the *Current Symptom Scale* the participant indicates how often each of the 18 DSM-IV ADHD symptoms is true on a 4-point Likert scale with the anchors "Not at All", "Once in a While", "Often" and "Very Often". The *Childhood Symptom Scale* asks the individual to rate the extent to which each symptom was true during childhood (i.e., 5-12 years of age). Each scale also asks the rater to indicate how much the symptoms interfered with the individual's social, academic, and adaptive functioning. Consistent with previous studies, items rated as occurring "often" or "very often" were coded as positive symptoms for analyses that required symptom counts (7).

Diagnostic interview. As part of the individual testing session at which the IQ, academic achievement, and neuropsychological measures were administered, each participant completed the *Adult ADHD Interview* described by Barkley and Murphy (1). The interview assesses the 18 DSM-IV ADHD symptoms and the extent to which the symptoms lead to significant impairment in academic functioning, social functioning, job performance, operation of motor vehicles, and management of daily responsibilities.

Measures of functional impairment

To ensure that participants met DSM-IV criteria C and D specifying that the symptoms of ADHD must lead to significant impairment across settings, all participants completed multiple measures of functional impairment as part of the initial screening. As noted previously, the *Current and Childhood Scales* and interview include specific questions regarding the impact of ADHD symptoms on the individual's social, occupational, educational, and overall daily functioning (1). To supplement these items, during the initial screening all participants completed a more detailed impairment questionnaire developed for this study (Willcutt, Bidwell, Hitt-Laustsen, McHaffie, & Banich, unpublished data, 2009). The impairment scale includes a broader range of questions regarding academic functioning (high school and college grade point average, completion of assignments, retention of academic material), interpersonal relationships (both friendships and romantic relationships), and specific aspects of adaptive functioning such as money management, driving performance, and occupational functioning. Finally, a summary measure of global functioning was obtained during the initial screening by asking the participant and parent to rate the individual's lowest overall functioning during the past year on a *Global Assessment of Functioning Scale* that corresponds directly to Axis V in DSM-IV.

The battery of impairment measures was used to derive composite measures of global, academic, social, and occupational functioning, management of daily responsibilities, and driving impairment. Significant impairment in each of these domains was defined by a score at or above the 93rd percentile of the total screening sample on the composite measure.

Intelligence and academic achievement

The Matrix Reasoning subtest from the Wechsler Adult Intelligence Scale, Third Edition (WAIS-III; 8) was administered to assess nonverbal abilities, and verbal abilities were measured by

the WAIS-III Vocabulary subtest. A linear transformation was used to rescale the subtest scores to the format typically used to report Verbal and Performance IQ (M = 100, SD = 15), and the mean of these scores was used as an estimate of Full Scale IQ.

The Woodcock-Johnson Tests of Achievement, Third Edition (WJ-III; 9) was used to assess academic achievement in mathematics (Calculations and Math Fluency) and reading-related domains (Letter-Word Identification, Word Attack, and Spelling). Reading disability was defined by a standard score below 85 on the Letter-Word Identification subtest, and math disability was defined by a score below 85 on the Calculations subtest.

Section 2. Description of outlier identification procedures

Outliers on the WM composite scores were determined using boxplots in SPSS. This method for identifying outliers is widely used and is highly robust to the presence of extreme values. Of the original 23 ADHD participants whose fMRI data passed quality control checks, three were flagged by SPSS as potential outliers. One value was greater than the third quartile by more than three times the interquartile range, a second value was greater than the third quartile by more than 1.5 times the interquartile range, and a third value was less than the first quartile by over three times the interquartile range. To avoid undue influence of these extreme values on the correlations of WM ability with activity, all three participants were dropped prior to analysis.

Section 3. ADHD diagnosis and medication history

Of the 20 individuals in the ADHD group, 19 had received a previous diagnosis of ADHD. Seventeen individuals had been prescribed psychostimulant medication during their lifetime, and 13 individuals had a current prescription for mixed amphetamine salts (Adderall; $N = 8$), methylphenidate (Concerta, $N = 3$; Ritalin, $N = 1$), or dexmethylphenidate (Focalin, $N = 1$). All participants were asked to refrain from their ADHD medications for the 24-hour period prior to the fMRI session.

Section 4. Definition of *a priori* search space for fMRI analyses

We constrained our fMRI analyses to the following regions: superior frontal gyrus, middle frontal gyrus, inferior frontal gyrus, precentral gyrus, anterior cingulate gyrus, frontal operculum, precuneus, supramarginal gyrus, angular gyrus, superior parietal lobule, inferior parietal lobule, fusiform gyrus, and superior temporal gyrus. An *a priori* mask was created from MNI voxels with at least 25% probability of being in one of those regions according to the Harvard-Oxford Cortical Structural Atlas (part of FSL; http://www.fmrib.ox.ac.uk/fsl/fslview/atlas-descriptions.html).

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