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Potential Symptoms of ADHD for Emerging Adults

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Abstract To identify potential diagnostic criteria for Attention-Deficit/Hyperactivity Disorder (ADHD) in emerging adults using a combination of *DSM-IV* and Barkley, Murphy, and Fischer's (2007) executive functioning (EF) items. Participants in ADHD and control groups self-report on: (1) the 18 *DSM-IV* criteria, (2) 87 Barkley et al. (2007) EF items, and (3) 10 impairment items. Factor analyses, expert ratings, and logistic regression analyses reveal two factors named Cognitive Inflexibility (CI) and Disinhibition (DI) that have potential diagnostic utility. Confirmatory factor analyses and further regression analyses reveal that specific *DSM-IV* items and items from CI and DI factors account for unique variance in self-reported impairment. Therefore, a 17-item set consisting of CI and DI items is proposed for further study. Reflecting the developmental nature of ADHD, a novel set of 17 items is shown to have potential diagnostic utility for emerging adults.

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Historically, Attention-Deficit/Hyperactivity Disorder (ADHD; American Psychiatric Association 2000) was believed to abate after puberty, and affected individuals were thought to "grow out" of the disorder by adulthood (DuPaul et al. 1991; Murphy and Barkley 1996a; Nadeau 1995; Wender 1987). However, approximately 70% of individuals diagnosed as children experience lasting impairment into adulthood (Weiss et al. 1985), and the overall prevalence rate of ADHD in adults is estimated to be 3.5–4.5% (Faraone and Biederman 2005; Heiligenstein et al. 1998; Murphy and Barkley 1996b; Kessler et al. 2006). Considering that ADHD persists into adulthood, it is of paramount importance to gain a more comprehensive understanding of ADHD in the overlooked transitional period between adolescence and adulthood. Recently, this developmental period for individuals in their late teens and early 20 s has been termed "emerging" adulthood (Arnett 2000). For classification purposes, the term emerging adult will be used to refer to individuals between the ages of 18 and 24, whereas the term typical adult will be used to refer to individuals between the ages of 26 and 64.

Emerging adulthood represents an important transitional stage marked by continued education and the beginning of careers that can define individuals throughout their lives. However, a dearth of research exists examining this important developmental period. A few longitudinal studies examining the persistence of ADHD have demonstrated impairment across the lifespan (e. g. Fischer et al. 1990; Gittelman et al. 1985; Manuzza et al. 1993; Weiss and Hechtman 1993). Likewise, there is a small body of cross-sectional research suggesting that emerging adults with

ADHD symptoms experience significant, pervasive impairment in multiple areas of functioning. Cognitively, Murphy et al. (2001) compared 17- to 28-year-olds in an ADHD group (n=105) and a control group (n=64) on measures of executive functioning. There were group differences on performance measures of interference control, inattention, response inhibition, and nonverbal working memory such that the ADHD group showed weaker performance than the control group. These results are fairly consistent with research on executive functioning in typical adults with ADHD (e.g., Corbett and Stanczak 1999). Academically, emerging adults with ADHD have lower college grade points averages (GPA) and higher dropout and academic probation rates, as compared to non-diagnosed peers (Heiligenstein et al. 1998). Attention problems were also found to be the most robust negative predictor of college GPA (Schwanz et al. 2007) and, when compared to controls, emerging adults with ADHD endorsed higher rates of academic concerns such as taking longer to complete assignments and needing to re-read material to understand it (Lewandowski et al. 2008).

With these studies providing initial evidence of impairment, a set of reliable and valid diagnostic criteria for emerging adults is seemingly in need of elucidation. Current *DSM-IV* diagnostic criteria were developed for, and field tested, on children and adolescents under the age of 17 (Lahey et al. 1994). A growing body of evidence suggests that *DSM-IV* criteria may therefore be less sensitive for diagnosing ADHD in older adolescent and adults (e.g., Biederman et al. 2000; Heiligenstein et al. 1998; Murphy and Barkley 1996b). Researchers have, in fact, asserted that using lower diagnostic cutoffs might improve diagnostic validity for adults (Barkley et al. 2007; Heiligenstein et al. 1998; Ratey et al. 1992), and that ADHD symptoms may manifest in a more understated manner in adults than in children (Wender et al. 2001). Accordingly, there is a strong need for ADHD criteria to be developed and normed for both emerging and typical adults. Establishing age-appropriate diagnostic criteria would quell lingering questions regarding the validity of the current diagnostic criteria for adults (e.g., Lewandowski et al. 2008) and aid in identification and subsequent treatment of adults who are experiencing impairment but do not currently meet diagnostic criteria based on the *DSM-IV.*

Attempting to satisfy the need for more research on ADHD criteria in adults, Barkley et al. (2007) studied possible symptoms for effectively classifying ADHD in typical adults. The authors included adaptive behavioral difficulties common to those presenting at an adult ADHD clinic and other items that corresponded to Barkley's (1997) theory of ADHD. The pool of potential items tapped executive functioning (EF), inhibition, self-regulation, verbal impulsiveness, response inhibition, cognitive inhibition, working memory abilities, and numerous other areas. The initial 87 item pool was evaluated via both structured interviews and rating scales with 146 adults (M=32.4 years of age, SD=10.9) who met *DSM-IV* ADHD criteria, 97 adults (M=37.8 years of age, SD=13.2) in a clinical control group, and 109 adults (M=36.4 years of age, SD=12.0) in a community control group. Through factor analysis and logistic regression, the authors arrived at a set of nine adult ADHD predictor items, three from the *DSM-IV* and six from the 87 item pool. Notably, the item set does not contain any hyperactivity symptoms, suggesting that: (1) typical adults diagnosed with ADHD may only evidence the Inattentive Type of ADHD and/or (2) typical adults have "grown out" of hyperactivity symptoms. Barkley et al. (2007) recommended a diagnostic cutoff of 6 out of 9 items on their scale rated as "Often" or "Very Often", with related impairment noted before age 16 (as opposed to age 7, per *DSM-IV* criteria).

Given that ADHD persists across the lifespan and acknowledging that symptom presentation likely changes with development (e.g., Biederman et al. 2000; Spencer et al. 1994), what remains undetermined is whether it is the *DSM-IV*, Barkley et al. (2007), or some other set of ADHD symptoms that is reliable and valid for emerging adults. The current study was designed to take a preliminary step toward this goal by pursuing the following three goals: (1) to replicate and extend Barkley et al.'s (2007) findings in a younger sample in an attempt to identify potential diagnostic items for emerging adults, (2) to compare any newly-indicated, potential items for emerging adults to the nine Barkley et al. (2007) typical adult symptoms and child derived *DSM-IV* criteria in their ability to predict group status and impairment, and (3) arrive at a list of items that may have the best utility for identifying emerging adults with ADHD. Based on previously discussed research establishing that symptom presentation varies across time, it was hypothesized that factors derived from the 87 Barkley et al. (2007) EF items would predict variance in ADHD-related impairment above and beyond existing *DSM-IV* criteria.

Method

Participants

One-thousand-forty-seven emerging adult participants were recruited from Appalachian State University (ASU, n=351), Oklahoma State University (OSU, n=358), and the University of Wyoming (UW, n=338). Participants were recruited from student disability services (SDS), research participant pools, and mental health clinics. Those recruited from SDS and mental health clinics were

paid $10 for participation, while those recruited from participant pools received one hour of credit toward a course requirement or extra credit. The sex composition of the sample was 56.5% women (n=592) and 43.5% men (n=455), which is generally representative of the sex distribution at all three universities. There were no significant sex differences on *DSM-IV* Inattention, *DSM-IV* Hyperactivity, or impairment scores. The ethnic composition of the sample was 85.0% European American, 3.8% African American, 3.6% Hispanic/Latino, 3.2% Native American, 2.0% Asian American, 1.3% biracial, and 0.8% other. There was no significant difference in the distribution of ethnicity across groups, χ^2 (2, N=1,044)= 0.42, *ns*, when ethnicity was coded as European American vs. non-European American.

Categorization of Participants into Groups

Participants were assigned to either the ADHD or control group. Individuals who either endorsed a previous ADHD diagnosis or currently met *DSM-IV* criteria for ADHD based on self-report were included in the ADHD group (73 men, 94 women). Specifically, 54 participants currently met ADHD criteria and had a previous diagnosis, 69 endorsed a previous diagnosis but did not currently meet *DSM-IV* criteria, and 44 currently met *DSM-IV* criteria but did not report a previous diagnosis. The control group consisted of 43 men and 97 women who indicated a diagnosis of learning, mood, or anxiety disorder without ADHD and 339 men and 401 women who did not endorse any psychological disorders.

Examination of participants in the ADHD group with a previous *DSM-IV* diagnosis revealed that 32.3% (n=54) were diagnosed by medical doctors, 16.2% (n=27) by doctoral-level therapists, and 1.2% (n=2) by masters-level therapists. Additionally, 60 (35.9%) participants in the ADHD group reported receiving therapeutic services while 107 (64.1%) participants denied any psychological or pharmacological treatment history. Notably, comorbidity was not used as an exclusion criterion.

Measures

Demographics Form Items included participant's sex, date of birth, ethnicity, years of education, college grade point average (GPA), college entrance exam scores (ACT), mental health treatment history, and year of initial ADHD diagnosis and type of diagnostician (if applicable).

Current Symptoms Scale—Self-Report Form (CSS) (Barkley and Murphy 2005) This form included 18 ADHD items for adulthood (past six months) tapping inattention, hyperactivity, and impulsivity. Ten age-appropriate, domain-keyed (e.g., family, work, social, education, relationships, money, driving, recreation, and daily responsibilities) impairment items were also included; however, these were administered following the presentation of the *DSM-IV* ADHD items as well as the 87 Barkley et al. (2007) items (see below) to fully capture ADHD-related dysfunction. Responses were made on a four-point frequency of experience scale (*Never/Rarely*, *Sometimes*, *Often*, *Very Often*). This measure closely follows the *DSM-IV* for ADHD diagnoses and takes 5 to 10 min to complete. Cronbach's alpha for *DSM-IV* Inattention, *DSM-IV* Hyperactivity, and impairment were .80, .73, and .86, respectively.

Participants were also asked to identify collateral informants for current (i.e., within the past 6 months) functioning. These informants were contacted via email to rate the participant's ADHD symptomatology at that specific time period. Unfortunately, overall response rates were very low (<10%) which precluded conducting extensive analyses within groups. However, correlational analyses revealed a substantial degree of concordance between participants and collateral informants (largely parents) for current r (62)=.62, p<.001 overall ADHD symptomatology.

Barkley Items The 87 Barkley et al. (2007) EF items related to ADHD in adults were used. As previously discussed, this item list consists of potential symptoms gathered through clinical interview and rating scales from individuals in a previous research study (Barkley et al. 2007). These items are thought to measure aspects of executive functioning including inhibition, self-regulation, verbal impulsiveness, response inhibition, cognitive inhibition, working memory abilities, and numerous other areas corresponding to Barkley's (1997) executive dysfunction theory of ADHD. Given the preliminary nature of these items, no data on psychometric properties have been published. Participants were asked to indicate how often in the last six months they displayed each symptom using the same four response choices used for the *CSS*. Cronbach's alpha for the current sample was .98.

Procedure

The study was approved by each university's Institutional Review Board. The study was completed online. Student Disability Services directors sent e-mails to students receiving accommodations at OSU and UW. At ASU, the same e-mail was distributed to individuals receiving tutoring services through Student Disability Services. The e-mail included a brief outline of the study, details about compensation, and a hyperlink to the experiment website. For recruitment via the research participant pools, the same description was provided on psychology department re-

search websites. Finally, recruitment flyers were posted in mental health centers at all three universities.

The first page of the website was the informed consent. This page included an outline of the purpose of the study, procedure, duration, risks, benefits, and compensation, after which individuals could elect to indicate their consent for participation. Afterwards, the remaining measures were presented in a standardized order (i.e., *Demographics Form*, *CSS DSM items*, *Barkley Items, CSS Impairment items*). Finally, a screen with debriefing information was displayed.

Results

Analytic Strategy Overview

In order to delineate potential items for identifying ADHD in emerging adults, we adopted an analytic strategy specifically developed by Smith and McCarthy (1995) for the refinement of clinical assessment instruments. As per their recommendations, the sample was randomly divided in half to facilitate exploratory and confirmatory analyses. Four exploratory stages of analysis were conducted with the first half of the sample. The factor structure of the 87 Barkley et al. (2007) EF items was first identified using exploratory common factor analysis. Second, the internal consistency of factors was established by examining the Cronbach's alpha coefficient of each scale, and by comparing inter-item correlations within factors to inter-item correlations across factors. Third, the content homogeneity of each factor was established. Experts were recruited to rate how prototypical each item was of the relevant constructs, and items were retained only if they were rated as prototypical of the factor they loaded on and not other factors. Fourth, we sought to isolate factors which discriminated individuals in the ADHD group using existing *DSM-IV* criteria from controls. Toward this end, logistic regression analyses were conducted in which the identified factors were entered as predictors of ADHD status. Only factors that predicted ADHD status were retained as potential items for the identification of ADHD in emerging adults.

Our next goal was to confirm the psychometric properties of the emerging factors in an independent sample (i.e., second half, retained for this purpose). A confirmatory factor analysis was conducted testing the adequacy of the retained factor structure in the second half of the sample. We also re-examined Cronbach's alpha coefficients to ensure internal consistency was maintained in an independent sample.

Next, we compared the obtained factors to potential alternative diagnostic criteria. These analyses were also conducted in the second half of the sample. First, we compared our obtained factors to the nine Barkley et al. (2007) typical adult ADHD items. The retained factors and the nine Barkley et al. (2007) typical adult ADHD items were entered as predictors of ADHD status in a logistic regression. Only those factors which proved to be valid predictors of ADHD status were retained for the final stage of analysis. In this final stage, we compared the retained factors to the *DSM-IV* diagnostic criteria for ADHD. Because ADHD status was strictly defined in terms of *DSM-IV* criteria, we turned to an alternative outcome measure for this purpose. Specifically, we used a measure of ADHD-related impairment. We entered the retained factors and the *DSM-IV* Hyperactivity and Inattention scales as predictors of ADHD-related impairment. We predicted that the identified factors from the 87 Barkley et al. (2007) EF item pool would predict variance in ADHD-related impairment above and beyond existing *DSM-IV* criteria.

Exploratory Analyses

Identification of Factor Structure First, as per the guidelines outlined by Smith and McCarthy (1995), we sought to identify the factor structure of 87 Barkley et al. (2007) EF items. To identify the number of factors which should be extracted, a parallel analysis first was conducted on the first half of the sample (Horn 1965; Lance et al. 2006). As recommended in the previous literature, 100 random data sets were used to generate mean eigenvalues of the same rank as the original data set. Eigenvalues were then retained if the calculated eigenvalue from the original data set exceeded the eigenvalue generated from the random data set (O'Connor 2000). This procedure suggested that seven factors should be retained.

To examine the seven-factor solution, an exploratory common factor analysis was conducted with a forced seven-factor solution in the first half of the sample. Because factors were expected to be inter-correlated, a promax rotation was applied (Floyd and Widaman 1995). Items were considered to load on a factor if they had only one loading of .4 or greater. This solution resulted in numerous interpretational difficulties. Two factors were clearly trivial in nature (Gorsuch 1983). The first contained only a single item and the second factor contained only three items. Furthermore, another extracted factor was not theoretically interpretable, in that it contained items related to both time perception (e.g., *Have difficulty judging how much time it will take to do something or get somewhere*) and physical coordination (e.g., *Clumsy, not as coordinated in my movements as others*).

Because of these difficulties in the interpretation of 3 of 7 factors, a 4-factor solution was adopted instead

(Gorsuch 1983). An exploratory common factor analysis was conducted with a forced four-factor solution. A promax rotation was applied, and items were considered to load on a factor if they had a single loading of .4 or greater on one factor. This solution yielded no trivial factors, and was clearly interpretable. The four-factor solution is presented in Table 1. The factors could be termed: (1) Cognitive Inflexibility (CI), (2) Failure to Plan/Persist (FP), (3) Disinhibition (DI), and (4) Inattention/Amotivation (IA).

Establishment of Internal Consistency Next, following the second step of the procedure outlined by Smith and McCarthy (1995), we sought to establish that the four obtained factors were internally consistent. Examination of the Cronbach's alphas in the first half of the sample indicated that all factors exhibited excellent internal consistency (CI α=.97; FP α=.94; DI α=.95; IA α=.87). Moreover, the average inter-item correlation within all factors (CI r=.50; FP r=.45; DI r=.42; IA r=.52) clearly exceeded the average inter-item correlation across factors (r=.36). Thus, the four-factor solution clearly captured meaningful differences in the item pool (Clark and Watson 1995).

Establishing Content Homogeneity Next, following the third step of the procedure outlined by Smith and McCarthy (1995), we sought to ensure that the obtained factors were conceptually homogeneous. Toward this end, 18 independent expert raters were recruited to determine the content homogeneity for each factor. In order to be considered an expert, all raters were licensed psychologists. Furthermore, they were required to have five or more years of post-degree experience working with individuals with ADHD. Theoretically-driven definitions of the underlying constructs of each factor were created by the authors. Experts then rated how prototypical each item was based on each of the four construct definitions. Raters were instructed that an item should only be considered prototypical if it constituted a conceptually-central and defining feature of the construct, rather than merely a correlate of the construct (Smith and McCarthy 1995). Ratings were made on a 1 to 5 scale (1 = strongly disagree; 2 = disagree; 3 = neither agree nor disagree; 4 = agree; 5 = strongly agree).

We retained only those items that experts agreed to be prototypical or highly prototypical of their factor. Towards this end, we retained only those items which received an average rating of 4 or higher (i.e., experts agreed or strongly agreed that the item is prototypical of the construct). We also wished to ensure that the items were most prototypical of the factor on which they loaded. Thus, we retained only those items which received their highest prototypicality rating for their factor. This procedure resulted in a total of 30 items; eight from the CI factor, nine from the FP factor, nine from the DI factor, and four from the IA factor. It is worth noting that Cronbach's alpha for the shortened factors remained high (CI α=.89; FP α=.88; DI α=.87; IA α=.81).

Inclusion of Factors that Discriminate ADHD from Controls Next, following the fourth step of the procedure outlined by Smith and McCarthy (1995), we sought to determine which of the obtained factors discriminate subjects with ADHD from controls. Preliminary analyses were conducted to identify covariates which should be included. Separate logistic regressions were conducted in which age, sex, and university affiliations were entered as predictors of ADHD status. Age was related to an increased likelihood of being diagnosed with ADHD, b=.07, Wald's χ^2=5.0, odds ratio=1.07, p=.025. UW also had a significantly lower likelihood of ADHD compared to OSU, b=−.22, Wald's χ^2=4.64, odds ratio=.80, p=.03; while OSU did not differ significantly from ASU, p=.74. Sex was unrelated to the likelihood of an ADHD diagnosis, p=.58. As such, age and university affiliation were retained as covariates for the remaining analysis.

A logistic regression was conducted using the first half of the sample to predict ADHD status. In step 1, age and university affiliation were entered as covariates. In step 2, participant's average score on each of the four factors (i.e., CI, FP, DI, and IA) was entered simultaneously predicting ADHD status. CI significantly predicted ADHD status, b=.81, Wald's χ^2=6.4, odds ratio=2.26, p=.01. DI also emerged as a significant predictor of ADHD status, b=1.06, Wald's χ^2=11.69, odds ratio=2.91, p<.001. However, FP and IA did not emerge as significant predictors. Thus, only the eight CI items and nine DI items were retained for further consideration as diagnostic criteria (see Table 2).

Confirmatory Analyses and Comparison to Alternative Diagnostic Criteria

Confirmation of Psychometric Properties Next, following Smith and McCarthy's (1995) guidelines, we sought to confirm the psychometric properties of the retained CI and DI items in an independent sample. To do so, we used the second half of the sample for all remaining analyses. A confirmatory factor analysis was conducted (see Fig. 1). Each of the eight CI items was constrained to load on a latent CI variable and each of the nine DI items was constrained to load on a latent DI factor. No cross-loadings were specified, and the CI and DI factors were specified as correlated. One parameter estimate of each latent variable was constrained to 1.0 to identify the model (Kline 1998). Four fit indices were used, including the Tucker-Lewis

Table 1 Factor structure of Barkley item pool

Item	CI	FP	DI	IA
Unable to "think on my feet" or respond as effectively as others	**.82**	.05	.21	.03
Can't seem to get to the point of my explanations as quickly as others	**.80**	.07	.07	.05
Often at a loss for words when I want to explain something to others	**.74**	.07	.05	.12
Slower to react to unexpected events	**.71**	.18	.01	.17
Have difficulties saying what I want to say	**.69**	.08	.06	.12
Unable to come up with or invent as many solutions to problems as others seem to	**.68**	.14	.04	.08
In trying to accomplish goals or assignments, find I am not able to think of as many ways of doing things as others	**.68**	.19	−.13	.04
Have trouble learning new or complex activities as well as others	**.64**	.19	−.04	−.07
Have difficulty explaining things in their proper order or sequence	**.62**	.10	.11	.00
Forget the point I was trying to make when talking to others	**.53**	−.17	.17	.25
When shown something complicated to do, cannot keep the information in mind so as to imitate or do it correctly	**.52**	.16	.03	.13
Feel I am not as creative or inventive as others of my level of intelligence	**.52**	.06	−.08	.03
Have trouble putting my thoughts down in writing as quickly as others	**.48**	.03	.04	.19
Trouble organizing my thoughts or thinking clearly	**.46**	.06	.09	.34
Not very flexible in my behavior or approach to a situation; overly-rigid	**.45**	.05	.26	−.10
Have difficulty using sound judgment in problem situations or when under stress	**.41**	.33	.18	−.05
Can't seem to remember things I have done or places I have been as well as others seem to do	**.41**	−.01	.15	.19
Don't seem to worry about future events as much as others	−.01	**.67**	.04	−.14
Fail to meet deadlines for assignments	−.04	**.65**	−.10	.12
Not prepared for work or assigned tasks	−.04	**.61**	.02	.15
Have trouble doing what I tell myself to do	.15	**.56**	−.08	.21
Have trouble planning ahead or preparing for upcoming events	.09	**.56**	−.04	.23
Have to depend on other to help me get my work done	.13	**.55**	.05	−.06
Inconsistent in the quality or quantity of my work performance	.15	**.54**	.14	.03
Show poor follow-through on promises or commitments made to others	.11	**.53**	.09	.01
Give poor attention to details in my work	.12	**.53**	.20	.28
Others tell me I am lazy or unmotivated	.05	**.52**	.07	−.01
Do not think about the future as much as others of my age seem to do	.06	**.52**	−.03	−.14
Things must have an immediate payoff for me or I do not seem to get them done	.05	**.51**	.08	.16
Lack self-discipline	.07	**.51**	−.06	.31
Can't seem to accomplish the goals I set for myself	.31	**.49**	−.13	.20
Unable to work as well as others without supervision or frequent instruction	.29	**.47**	.08	−.03
Trouble following the rules in a situation	−.06	**.46**	.37	−.02
Do not put as much effort into my work as I should or than others are able to do	−.04	**.45**	.18	.28
Don't think about or talk things over with myself before doing something	.03	**.43**	.35	−.08
Can't seem to defer gratification or to put off doing things that are rewarding now so as to work for a later goal	.08	**.43**	.09	.22
Waste or mismanage my time	−.02	**.41**	.11	.36
Poor sense of time	.10	**.40**	.09	.22
Make impulsive comments to others	−.05	.14	**.67**	−.01
Quick to get angry or become upset	.20	−.14	**.64**	.03
Make decisions impulsively	−.13	.22	**.62**	.04
Get silly, clown around, or act foolishly when I should be serious	−.02	.01	**.56**	.16
Over-react emotionally	.28	−.20	**.53**	.04
Likely to do things without considering the consequences for doing them	−.10	.31	**.52**	.03
Change my plans at the last minute on a whim or last minute impulse	−.13	.20	**.47**	.21
Accident prone	.29	.03	**.44**	−.10
Unable to inhibit my reactions or responses to events or others	.13	.16	**.41**	.10
Have trouble motivating myself to start work	.03	.19	−.12	**.71**

Table 1 (continued)

Item	CI	FP	DI	IA
Have difficulty resisting the urge to do something fun or more interesting when I am supposed to be working	.01	.16	.02	**.67**
Procrastinate or put off doing things until the last minute	−.19	.20	.10	**.62**
Can't seem to get things done unless there is an immediate deadline	.05	.25	.03	**.56**
Can't seem to persist at things I do not find interesting	.14	.17	.08	**.50**
Not able to comprehend what I read as well as I should be able to do; have to re-read material to get its meaning	.38	−.21	.08	**.48**
Prone to daydreaming when I should concentrate on something	.17	.03	.18	**.48**
Have trouble staying alert or awake in boring situations	.19	−.09	.23	**.44**

Items not significantly loading on a factor are not presented

CI cognitive inflexibility, *FP* failure to plan/persist, *DI* disinhibition, and *IA* inattention/amotivation

Index (TLI), comparative fit index (CFI), the root-mean-square error of approximation (RMSEA), and the standardized root-mean-square residual (SRMR). Adequate fit was designated as TLI and CFI values of .90 or greater (Bentler 1992) and RMSEA and SRMR values of .10 or less whereas excellent fit was designated as TLI and CFI values close to .95, RMSEA values close to .06, and SRMR values close to .08 (Hu and Bentler 1999).

The results of the initial CFA suggested that the proposed factor structure approximated an adequate fit of the data, χ^2 (136, N=523)=513.05, p<.001; TLI=.87, CFI=.88, RMSEA=.08, SRMR=.06. Modification indices indicated that freeing error covariances might improve the fit of the model, as recommended by Jöreskog (1993). Thus, conceptually justified error covariances (i.e., items believed to tap similar symptoms) were freed. The revised model suggested a closer fit to the data, χ^2 (115, N=523)= 301.06, p<.001; TLI=.94, CFI=.95, RMSEA=.05, SRMR=.05. Examination of the modification indices suggested that none exhibited cross-loadings. Furthermore, all of the items loaded substantially on their respective factors (>.40).

Comparison of Cognitive Inflexibility and Disinhibition Items to Alternative Diagnostic Criteria Following Smith and McCarthy's (1995) recommendations, we sought to determine whether the 8-item CI and 9- item DI scales had diagnostic utility beyond alternative existing criteria. In our previous analyses, we obtained only one of the nine Barkley et al. (2007) typical adult ADHD items (i.e.,

Table 2 Cognitive inflexibility and disinhibition items

Item	Source
Trouble organizing my thoughts or thinking clearly	CI
When shown something complicated to do, cannot keep information in mind so as to imitate or do it correctly	CI
Not very flexible in my behavior or approach to a situation; overly rigid in how I like things done	CI
Unable to come up with or invent as many solutions to problems as others seem to	CI
Have trouble putting my thoughts down in writing as well or as quickly as others	CI
In trying to accomplish goals or assignments, find I am not able to think of as many ways of doing things as others	CI
Have difficulty explaining things in their proper order or sequence	CI
Unable to "think on my feet" or respond as effectively as others to unexpected events	CI
Make decisions impulsively	DI
Unable to inhibit my reactions or responses to events or others	DI
Make impulsive comments to others	DI
Likely to do things without considering the consequences for doing them	DI
Change my plans at the last minute on a whim or last minute impulse	DI
Quick to get angry or become upset	DI
Over-react emotionally	DI
Get silly, clown around, or act foolishly when I should be serious	DI
Accident prone	DI

CI cognitive inflexibility, *DI* disinhibition

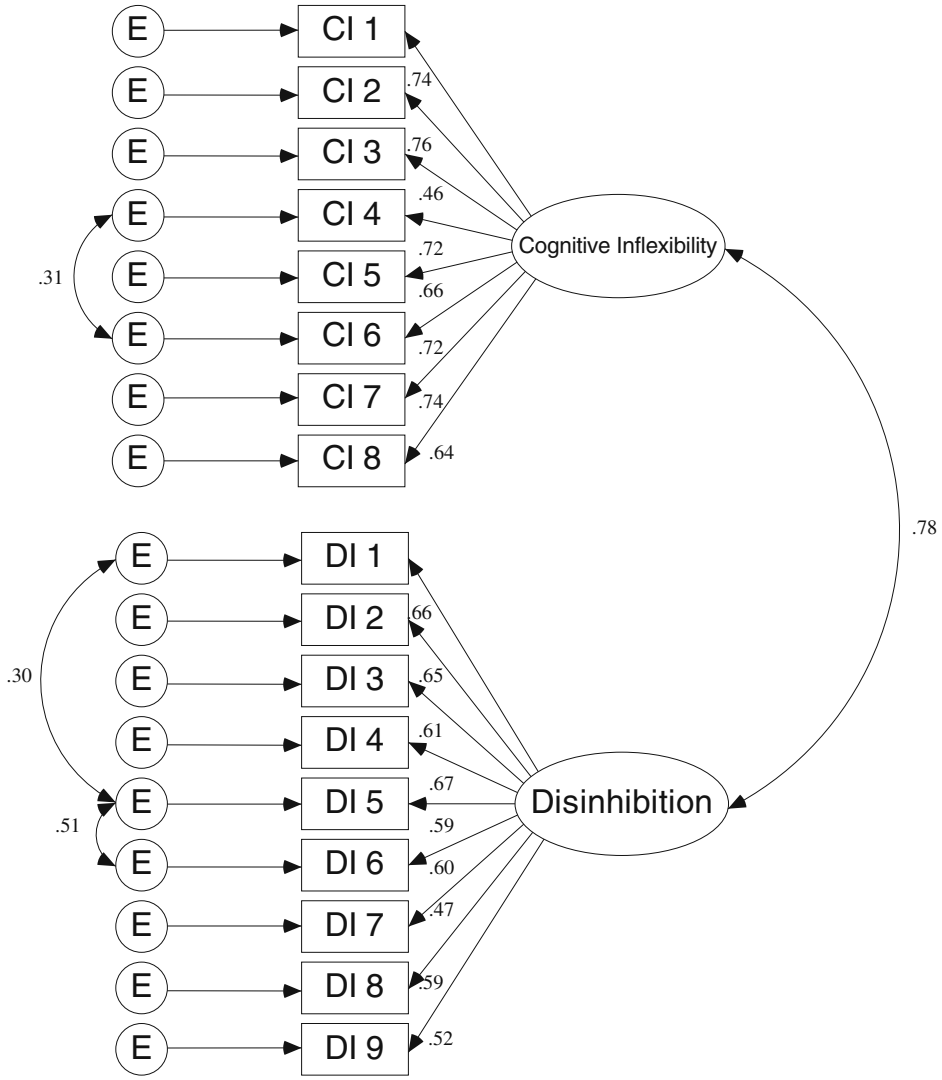

Fig. 1 Confirmatory factor analsyis of cognitive inflexibility and disinhibition scale. Note. Cognitive Inflexibility and Disinhibition items are numbered in the order they appear on Table 2

Note. Cognitive Inflexibility and Disinhibition items are numbered in the order they appear on Table 2.

"Makes decisions impulsively.") Thus, we compared the diagnostic utility of CI and DI scales to the remaining eight Barkley et al. (2007) typical adult ADHD items. Toward this end, we simultaneously entered CI, DI, and eight Barkley et al. (2007) typical adult ADHD items as predictors of ADHD status in a logistic regression. Age and university were entered as covariates. All three scales significantly predicted ADHD status, CI: b=1.46, Wald's χ^2=17.5, odds ratio=4.33, p<.0001; DI: b=.81, Wald's χ^2=4.44, odds ratio=2.26, p=.03; Barkley: b=1.2, Wald's χ^2=9.33, odds ratio=3.40, p=.002. Thus, all three scales were retained for further analysis.

In our final analysis, we sought to determine whether the CI, DI, and nine Barkley et al. (2007) typical adult ADHD items had diagnostic utility beyond existing *DSM-IV* criteria. Because ADHD status was strictly defined in terms of the existing *DSM-IV* criteria, it was necessary to move beyond ADHD status as a validating criterion at this point in the analyses. As such, we adapted ADHD-related impairment as a criterion measure. A multiple regression analysis was conducted. Age and university were entered as covariates at Step 1. *DSM-IV* Inattention, *DSM-IV* Hyperactivity, eight Barkley et al. (2007) typical adult ADHD items, CI, and DI scales were entered at Step 2. *DSM-IV* Inattention (β=.17, p<.001), and *DSM-IV* Hyperactivity (β=.11, p=.01), CI (β=.26, p<.0001), and DI (β=.29, p<.0001) scales all accounted for unique variance in impairment. The eight Barkley et al. (2007) typical adult ADHD items, however, did not significantly predict impairment (β=.07, p=.15). As such, we conclude that the CI and DI scales have diagnostic utility above and beyond *DSM-IV* items, while the eight Barkley et al. (2007) typical adult ADHD items did not predict incremental impairment. Thus, the CI and DI items should be further

examined as potential diagnostic criteria for ADHD in this population.

Discussion

A small number of studies have demonstrated that *DSM-IV* diagnostic criteria may be limited in developmental appropriateness. In particular, researchers have questioned the validity of current ADHD criteria, argued for decreased symptom thresholds, or voiced a need for creation of developmentally appropriate criteria for adolescent and adult populations (Barkley et al. (2007); Heiligenstein et al. 1998; Murphy and Barkley 1996b; Wender et al. 2001). The aim of this study was to replicate and extend the typical adult derived Barkley et al. (2007) findings by identifying potential developmentally appropriate diagnostic items for ADHD in emerging adults using the 87 Barkley et al. (2007) EF items. Two factors emerged which predicted ADHD status, namely Cognitive Inflexibility (CI) and Disinhibition (DI). Consistent with predictions, both factors accounted for unique variance in ADHD-related impairment above and beyond *DSM-IV* criteria. As such, the 8-item CI and 9-item DI scales should be further examined as potential diagnostic items for emerging adults. Additionally, of these 17 items, only one item (*often makes decisions impulsively*) was present in the final symptoms lists of the Barkley et al. (2007) study and the current study. In other words, our findings were not commensurate with Barkley et al.'s (2007).

Barkley et al. (2007) addressed developmental concerns about using child and adolescent derived diagnostic criteria with adults by proposing new diagnostic criteria. However, their sample had a mean age of 32.4 years whereas the current sample had a mean age of 20.0. Age differences across these two studies may explain the different findings. Furthermore, these findings fit well with research demonstrating that brain development, in particular the dorsal lateral prefrontal cortex, does not fully cease until approximately 25 years of age (Giedd 2004). The dorsal lateral prefrontal cortex controls impulses, coordinates motor functioning, and is involved in planning. Therefore, we posit that the developmental nature of ADHD might explain why both the 87 Barkley et al. (2007) EF items and *DSM-IV* criteria accounted for unique variance in impairment compared to the nine Barkley et al. (2007) typical adult ADHD items.

Theoretical Implications

When examining the items in our symptom list, several interesting trends emerged. First, the validity of the DI and CI scales in our sample could provide support for Barkley's (1997) theory of ADHD for this age group. Specific to response inhibition, Barkley posited that individuals with ADHD evidence deficits in executive functions including planning, inhibition, and goal directedness that aid individuals in evaluating choices, inhibiting pre-potent-yet-inappropriate responses, evaluating the context of decisions, and deciding on a course of action (Welsh and Pennington 1988; Willcutt et al. 2005).

Barkley (1997) further specified dysfunctional response inhibition as the core deficit in ADHD. This includes inhibition of a pre-potent response, interrupting an ongoing response, and interference control. Several items from the DI scale seem to reflect this core deficit: (1) *unable to inhibit my reactions or responses to events or others*, (2) *make impulsive comments to others*, and (3) *make decisions impulsively*. The CI items, however, appear to be largely related to working memory. Working memory was hypothesized by Barkley (1997) to be a secondary deficit stemming from response or behavioral disinhibition. Working memory is conceptualized as a limited capacity system composed of the coordinating central executive system and the phonological loop and visuo-spatial sketchpad slave systems (Baddeley 2003). Working memory allows individuals to temporarily hold and manipulate information while solving problems or engaging in cognition. Interestingly, working memory has become an area of increasing interest for ADHD-researchers in recent years. A recent meta-analysis examining working memory in children with ADHD identified several converging trends (Martinussen et al. 2005). Across all studies, significant differences and medium to large effect sizes were found such that children with ADHD performed worse on working memory tasks. Furthermore, literature on working memory deficits suggests significant impairment in adults with ADHD (e.g., Barkley et al. 1996; Engelhart et al. 2008; Marchetta et al. 2008, Murphy et al. 2001).

However, before considering these items to be reflective of executive functioning deficits, it would be important to determine if these CI and DI items are in-fact, reflective of executive functioning components (e.g., working memory and inhibition). One could argue that several items in the CI and DI scales (e.g. *make decisions impulsively*) are essentially revised *DSM-IV* criteria and, therefore, not exclusively measuring executive functioning. Furthermore, although recent research on working memory and inhibition has revealed patterns of deficits in individuals with ADHD (e.g., Engelhart et al. 2008; Nigg et al. 2005; Sonuga-Barke 2005; Willcutt et al. 2005), these deficits are not uniform to all individuals with ADHD. In fact, research has suggested that self-report measures of executive functioning are divergent from task-based neuropsychological testing (Biederman et al. 2008a). Participants scoring highly on a

similar behavioral questionnaire as used in the current study were found to evidence high levels of comorbidity, ADHD symptoms, and occupational impairment whereas individuals meeting psychometric executive functioning criteria only were found to have lower full scale IQ and math achievement and reading scores. Therefore, the current findings should be interpreted cautiously, and continued research on executive functioning in individuals with ADHD needs to be conducted.

In comparing the CI and DI scales to both *DSM-IV* criteria and the nine Barkley et al. (2007) typical adult ADHD items several other interesting trends emerge. It appears that perhaps as individuals develop from childhood to adulthood, symptoms of hyperactivity decrease in number. In particular, the DI scale contains several items that could be conceptualized as impulsive or reflective of previously described response inhibition (e.g., *Make impulsive comments to others*, *Quick to get angry or become upset*, and *Likely to do things without considering the consequences for doing them*). This stands in contrast to the nine Barkley et al. (2007) typical adult ADHD item set that contains far fewer items of this type. Additionally, emerging adults appear to evidence problems with cognitive flexibility or working memory issues compared to the problems with inattention and distraction characterized by the nine Barkley et al. (2007) typical adult ADHD items. It is plausible that as individuals with ADHD develop they slowly learn to inhibit or decrease overt hyperactive behaviors but maintain difficulties with cognitive impulsivity and inflexibility. Therefore, as typical adults they may evidence cognitive impulsivity in addition to inattentive behaviors due to these underlying causes.

Notwithstanding, it appears that CI and DI items and *DSM-IV* criteria are potentially useful for examining ADHD in emerging adults. The CI and DI scales were derived from larger factors that effectively discriminated between ADHD and control groups. Examination of these factors also revealed that they map onto existing theories and factor structure of typical deficits of at least a subset of individuals with ADHD. Based on this information, these items should be considered further as potentially diagnostic for ADHD in emerging adults.

Clinical Implications

The current results suggest that emerging adults with ADHD may evidence specific symptoms reflective of both Barkley's (1997) theory of ADHD and *DSM-IV* symptoms. Therefore, in clinical practice at university clinics and elsewhere, it would be beneficial to consider using these items in an adjunctive manner. For instance, these items could be used in conjunction with *DSM-IV* ADHD symptoms during a clinical interview, and as confirmative information in case of an otherwise borderline (i.e., subclinical) ADHD diagnosis. However, future studies are needed to test these items in different populations (e.g. individuals with and without psychometrically defined executive functioning deficits).

Strengths, Limitations, and Future Directions

The current study offers several unique contributions to the ADHD literature. We attempted to establish potential diagnostic items for an important developmental transition period between adolescence and adulthood. This study can be seen as an important first step in addressing the paucity of diagnostic information for ADHD in emerging adults. Additionally, this study builds upon a previous study (Biederman et al. 2008b) that analyzed the 87 EF items using factor analysis only and contained participants ranging from 18 to 55 years old. The current study focused on self-reported impairment in the identification of the proposed criteria to avoid the circular confound of using *DSM-IV* criteria, which may have limited validity for adults, for categorization. Given the debate surrounding the diagnostic utility and applicability of *DSM-IV* criteria to adults, predicting self-reported impairment can be seen as advantageous (Gordon et al. 2008). The current study also included a large sample of individuals with ADHD, other mental health problems, and typical controls (N=1,047).

Despite these strengths, this study also possesses several limitations. Group categorization and symptoms were based on self-report responses only. Therefore, shared source variance as a result of predictor and outcome variables being completed by the same participant should be noted. Although attempts were made to gather collateral informant responses to confirm participant's ADHD status, response rates via e-mail were extremely low (<10%). Therefore, mental health diagnoses were not confirmed by collateral informants. Although determining ADHD status based on self-report is less stringent than gathering data from multiple informants, recent research demonstrates that the concordance of self-report, collateral informant (e.g., parents or significant others), and investigator report ranges from acceptable to good with ADHD-related measures (Adler et al. 2008; Belendiuk et al. 2007; Dias et al. 2008; Magnússon et al. 2006; Murphy and Schachar 2000; Kessler et al. 2006). The previously reported correlations in the current study appear to coincide with these findings. Additionally, comorbid externalizing disorders which may help explain some findings were not queried. Participants were not asked about current or previous treatment with medication or behavior therapy exclusive to ADHD. Instead, participants were asked about their general mental health treatment history. With ADHD specific treatment information, possible analyses could have been conducted

to determine what differences, if any, existed between individuals currently taking medication or receiving treatment for ADHD and those who were not. Specifically, given that current treatment might reduce symptomatology, the fact that symptom levels were predictive of current impairment may be even more impressive.

In light of these limitations, the current study suggests that more research is needed to uncover potential differences between emerging adults and typical adults with ADHD. In particular, the current study included college students as participants and generalization to other age groups, or same-aged peers who are not in college, should be conducted with caution. Barkley et al.'s (2007) study was completed by interviewing participants about the 87 EF items and determining a dichotomous response. Although the current study included all 87 EF items, collecting the data through an online checklist with four possible responses was not an exact replication. Using an interview to assess behavior could improve the likelihood that participants fully understood the items and allow the interviewer to expand on items in order to achieve an accurate response. However, given that Pelham et al. (2005) argued that structured interviews do not necessarily provide incremental validity in assessing ADHD, conducting interviews may not have influenced the results. Future studies should also include a more ethnically diverse group of emerging adults, given that the vast majority of our sample was European American. Determining whether specific Barkley et al. (2007) EF items have utility for ADHD in children and adolescents could also be informative. Finally, given that the CI factor could be related to working memory, studies specifically testing working memory and the 17-item set are encouraged.

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