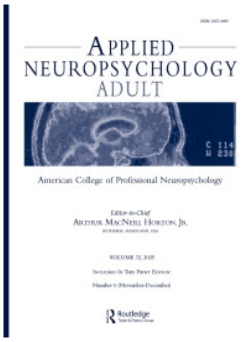

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Internal and predictive validity of subscale scores of the short-form Barkley Deficits in Executive Functioning Scale (BDEFS) in research

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ABSTRACT

Objective: We examined the five-factor structure of the items on the short-form Barkley Deficits in Executive Functioning Scale (BDEFS). Internally, the subscale structure of the form was verified, and associations between the short- and long-form subscales were investigated. To establish predictive validity, the associations of the BDEFS subscale scores (short and long-forms) with symptoms of attention deficit hyperactivity disorder (ADHD) and cognitive disengagement syndrome (CDS), as well as negative affect (depression and anxiety) were investigated.
Method: Australian university students ($N=608$; aged 17–69 years, 23.5% men, 75.5% women and 1.0% others) completed self-reports of EF, ADHD, CDS, depression and anxiety.
Results: Overall, the five-factor model of the short-form BDEFS items was the best balance of fit and parsimony, and the factors aligned with the five subscales. Measurement invariance was shown across gender and age-group. The short-form subscales were highly correlated with their counterparts in the long-form, and subscale scores based on each form produced the same pattern of correlations and unique associations with ADHD and CDS, controlling for depression and anxiety.
Conclusion: The short-form BDEFS produces five valid and reliable subscales that can be used in place of the long-form subscales when a more efficient method of data collection is desired.

KEYWORDS
ADHD; Barkley Deficits in Executive Functioning Scale (BDEFS); cognitive disengagement syndrome (CDS); executive function (EF)

Introduction

Executive functions (EFs) are a group of interrelated cognitive abilities important for effortful top-town processing (Barkley & Murphy, 2011; Diamond, 2013; Duncan, 1986; Lezak, 1982; Miyake et al., 2000; Willcutt et al., 2005). Although researchers debate its precise components, there is a general consensus that EF encompasses core processes of inhibitory control, working memory, and cognitive flexibility, as well as higher-order functions such as reasoning, problem solving and planning (Barkley & Murphy, 2011; Diamond, 2013; Jurado & Rosselli, 2007; Lezak, 1982; Miyake et al., 2000; Snyder et al., 2015). EF difficulties impact purposeful and goal-directed behaviors that play critical roles in completing educational, occupational, and daily-life tasks, resulting in overall poorer quality of life (Bikic et al., 2017; Diamond, 2013; DuPaul et al., 2021; Etnier & Chang, 2009; Stern et al., 2017; Weyandt et al., 2017; Willcutt et al., 2005). These EF impairments are known to occur among individuals with neurodevelopmental conditions, such as attention deficit hyperactivity disorder (ADHD) and cognitive disengagement syndrome (CDS, originally named sluggish cognitive tempo) (Barkley & Murphy, 2011; Jarrett et al., 2017; Kamradt et al., 2014; Kennedy et al., 2008; Wood et al., 2017). Accurate assessment of EF is therefore critical in understanding the diverse patterns of EF impairment within these groups (Barkley & Murphy, 2011; Diamond, 2013; Kennedy et al., 2008).

ADHD is defined as pathological inattention and/or hyperactivity or impulsiveness (American Psychiatric Association [APA], 2013). In adults, those with symptoms of inattention have difficulties maintaining focussed attention, are easily distracted, and frequently make careless mistakes (APA, 2013). Hyperactivity, when persisting into adulthood, often presents as persistent restlessness or fidgeting, sometimes accompanied by excessive speech (APA, 2013). Impulsivity is described as persistent difficulties in waiting for one's turn in conversation or other activities, and haste in action or decision-making (APA, 2013). Together these symptoms impair the individual's social and occupational functioning, resulting in lower employment and income and more general difficulties in daily living skills such as driving (Brown & Casey, 2016; Kessler et al., 2006). CDS describes a set of behavioral characteristics mainly composed of under-activity, a slow and foggy mind, and a tendency to daydream excessively or become lost in one's own mind (Barkley, 2014; Becker, 2021; Becker et al., 2016). CDS was originally conceptualized as an inattention only subtype of attention deficit disorder, but recent evidence suggests that CDS and ADHD inattention are two different conditions (Barkley, 2012; Barkley et al., 2022; Becker, 2021; Becker et al., 2016, 2023; Becker & Barkley, 2021). However, their high comorbidity and similarities raise the need to differentiate them in research and application (Barkley, 2012, 2013; Fredrick & Becker, 2021; Jarrett et al., 2017; Wood et al., 2017).

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Table 1. Five factors of BDEFS (Barkley, 2011b).

Deficits in self-management of time	• Difficulties in planning for the future and preparing, initiating, and completing an activity in time • Problems with the sense of time and prioritization
Deficits in self-organization /problem-solving	• Difficulties in cognitive processes of organization, i.e., problems with the ability to hold, categorize and process information input in a timely manner, as well as the ability to structuralize and cogently express one's own thoughts • Problems with learning new materials or activities, problem solving, and plan execution
Deficits in self-restraint (inhibition)	• Problems in withholding inappropriate first reactions based on the situation, one's past experience or/and potential consequences • Difficulties in tolerating frustration
Deficits in self-motivation	• Problems with the intrinsic drive and sustained commitment toward the attainment of long-term objectives without immediate gratification or external enforcement mechanisms
Deficits in self-regulation of emotion	• Difficulties in regulating one's negative emotion according to the environmental requirements and one's own goals • Difficulties in retaining objectivity under emotion

One of the most commonly used assessments of EF difficulties in both ADHD and CDS is the Barkley Deficits in Executive Functioning Scale (BDEFS, Barkley, 2011b), which is theoretically based on Barkley's model of EF deficits found in ADHD (Barkley, 2011b; Barkley & Murphy, 2011). The BDEFS contains five subscales designed to capture the different components of EF crucial for daily function: (1) self-management of time, (2) organization/problem solving, (3) inhibitory control (self-restraint), (4) motivation and (5) emotion regulation (Table 1 provides a detailed description of these factors). Notably, Barkley (2012) suggested that varied patterns of EF impairments in individuals would lead to differentiable profiles in BDEFS responses.

The BDEFS has both long- and short-forms (Barkley, 2011b). The 89-item long- form was first developed, with the 20-item short form later produced by selecting the four items with the highest factor loadings from each subscale of the long-form (Barkley, 2011b). Both the long- and the short-form BDEFS produce composite scores within subscales and the subscales can be combined to produce a total EF score (Barkley, 2011b). However, normative data for the subscales was generated for the long form only, with a recommendation that the short-form BDEFS should primarily be used as a screening instrument in clinical interviews to determine whether further assessments should be administered (Barkley, 2011b). To that end, most research has considered the psychometric properties of subscales from the long-form BDEFS. This work supports the five-factor structure of EF deficits with factor analysis, and has demonstrated the utility of subscales in uncovering the unique contributions of particular EF deficits on ADHD and CDS (Dehili et al., 2017; Godoy et al., 2023; Jarrett et al., 2017; Kamradt et al., 2021; Wood et al., 2017).

The limited exploration of the internal and predictive validity of the short-form BDEFS subscales is a notable gap in the literature. Indeed, if the validity of the short-form subscales of the BDEFS can be established, their use in research would be of practical benefit for two reasons. First, compared with the long-form and other EF scales (e.g., the 75-item Behavior Rating Inventory of Executive Function, the adult version, or BRIEF-A, Roth et al., 2005), using the short-form BDEFS would substantially reduce assessment time. Reducing assessment time would be advantageous for individuals with shorter attention spans, or when researchers and practitioners need to measure multiple psychological constructs in one session without inducing client fatigue. Second, using the short-form scale would also improve consistency across studies, as there is only one version of the short-form scale but different versions of the long-form scale that have different items either included or excluded (e.g., Barkley, 2012; Kamradt et al., 2021). The use of a consistent measure would allow for clear comparability across studies on clinical populations associated with EF deficits, like ADHD and CDS.

Therefore, to fully utilize the short-form BDEFS, more research toward the establishment of its validity, at the level of its subscales, is required (Allee-Smith et al., 2013). To date, the subscale structure of the short-form has only been investigated in four published studies, three using large community samples (Clauss et al., 2021; Kim et al., 2019; Lace et al., 2022), and one with a sample of college students (Hernandez-Vallant et al., 2025). These studies employed confirmatory factor analysis (CFA) to test the competing theories viewing BDEFS as either a unidimensional or multidimensional measure (with two or five factors, some depicted in Figure 1, Clauss et al., 2021; Hernandez-Vallant et al., 2025; Kim et al., 2019; Lace et al., 2022). In all studies, the five factors corresponding to the five subscales originally produced for the short-form rendered good fit (Clauss et al., 2021; Hernandez-Vallant et al., 2025; Kim et al., 2019; Lace et al., 2022). In addition, the unidimensional model in the studies that tested it had a poor fit to the data (Clauss et al., 2021; Hernandez-Vallant et al., 2025; Lace et al., 2022). However, there were different views on whether these results supported the multidimensionality of the short form.

On the one hand, Lace et al. (2022) reported that, based on statistical comparison of the models via χ^2-difference tests, the correlated five-factor model had a superior fit relative to the one- and two-factor models tested. On the other hand, both Clauss et al. (2021) and Hernandez-Vallant et al. (2025) concluded that, the second-order model (one general latent factor indicated by the five factors) and the bifactor model (one general factor, with five factors generated from residual variance) also had good fits, and the bifactor model had superior statistical fit. Based on their results from the bifactor model, whereby the general factor accounted for the vast majority of variance in BDEFS scores, they suggested primarily using the overall score of the short-form scale rather than using the individual subscales (Clauss et al., 2021; Hernandez-Vallant et al., 2025).

Nonetheless, broader methodological studies suggest that bifactor models tend to overfit data, or fit random data (Bonifay et al., 2017; Gignac, 2007; Murray & Johnson, 2013; Rodriguez et al., 2016). Thus, several researchers have argued that the judgment of dimensionality of a scale should be based on a combination of *both* theory and statistical outcomes (Bonifay et al., 2017; Murray & Johnson, 2013; Rodriguez et al., 2016). Applying this logic to the short-form BDEFS, although the bifactor model produced superior fit in two studies (Clauss et al., 2021; Hernandez-Vallant et al., 2025), the theoretically derived subscales of the BDEFS short-form could still reflect meaningful variation in the profile of EF deficits across different individuals. In fact, Hernandez-Vallant et al. (2025) reported significant differential associations between the short-form subscales and indicators of alcohol use in their college sample. Therefore, more studies are needed to explore the latent structure of the short-form BDEFS, considering both theory and statistical fit.

Theoretically, EF deficits have been associated with ADHD, and CDS (Barkley, 2012; Feldman et al., 2013; Jarrett et al., 2017; Snyder et al., 2015; Wood et al., 2017). Specifically, the unique associations between a particular EF deficit and the inattention or hyperactivity/impulsive component of ADHD, or CDS, have been found to differentiate the presentation of each condition. For example, two studies using the complete long-form BDEFS reported that CDS had significant unique positive contribution on all EF subscale scores, with strongest impacts on the organization subscale (Jarrett et al., 2017; Wood et al., 2017). In contrast, ADHD inattention made a significant unique positive contribution on all EF subscale scores except the emotion regulation score, with the strongest impacts on the motivation and time management scales (Jarrett et al., 2017; Wood et al., 2017). In addition, ADHD hyperactive/impulsive was associated only with inhibition (self-restraint) and emotion regulation (Jarrett et al., 2017; Wood et al., 2017). Importantly, if using the short-form subscales demonstrate the same pattern and similar results as do the long-form subscales, for ADHD and CDS, it would support the predictive validity of the short-form subscales, while highlighting their practical benefits for use in research.

As such, the current study had two aims. First, the factor structure of the short-form scale, was investigated together with the associations between scores from the short- and long-form EF subscales. Such work is crucial, as it has been argued that the internal validity of a short-form scale requires investigating the extent to which its factors provide a good

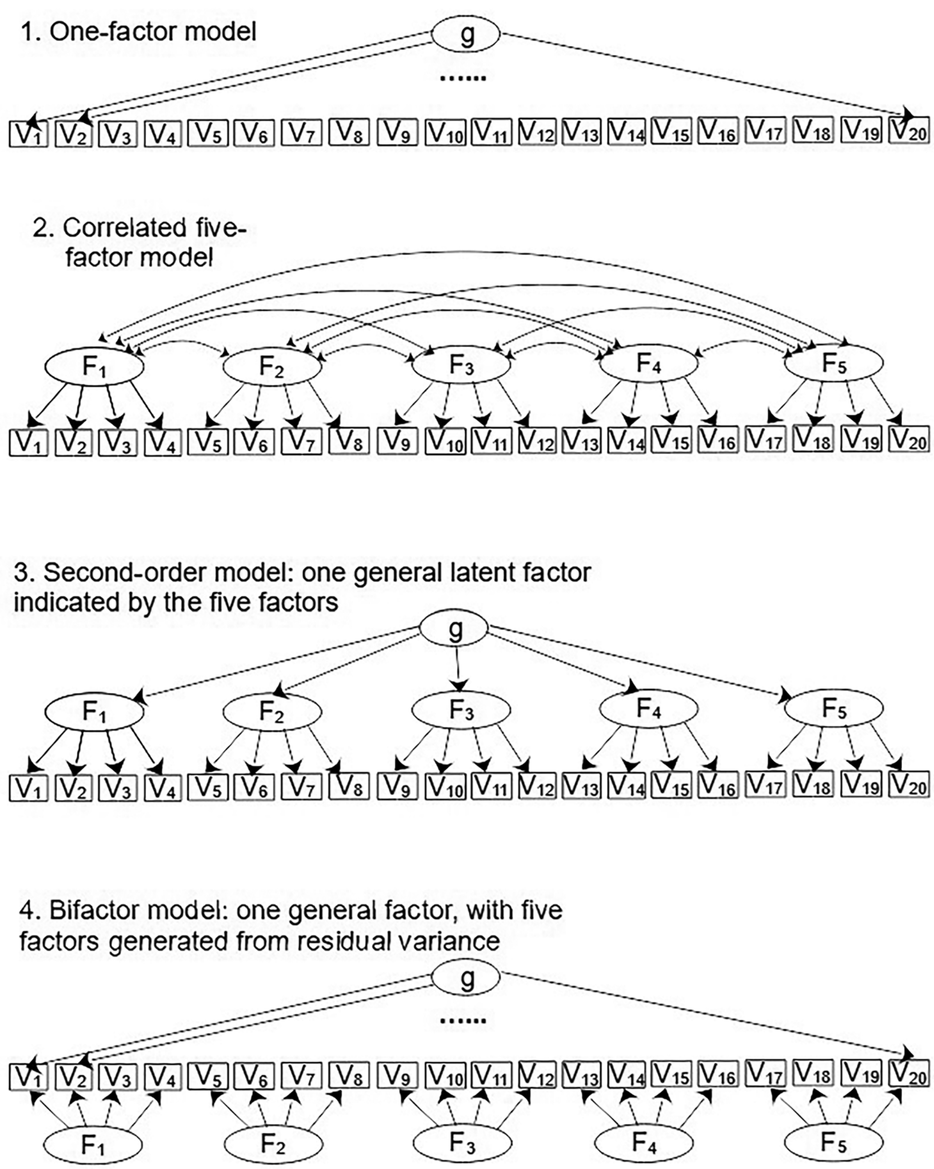

Figure 1. Four models tested with confirmative factor analyses in previous studies (Clauss et al., 2021; Kim et al., 2019; Lace et al., 2022).

representation of those assessed with the long form (Stanton et al., 2002). In addition, measurement invariance across samples, gender and age-group was tested for the five-factor model to ensure that the scale measures the same construct consistently across these different groups. Second, the validity of the short-form scale was explored by examining the associations between the scale and other established constructs associated with unique EF profiles across the five factors seen when using the original long-form scale (Stanton et al., 2002). Specifically, the unique EF profiles of ADHD and CDS found in previous research were explored (e.g., Wood et al., 2017).

Method

Participants and procedure

Two cohorts of undergraduate students from an Australian multicampus (urban and regional) university responded to the study advertisement posted on the university research volunteer recruitment website and volunteered to participate in the study in exchange for course credit. The study was approved by the university research ethics committee, and electronic informed consent was obtained from each participant prior to participation. The first cohort (Sample 1) consisted of 399 participants recruited from June to October 2022, and the second cohort (Sample 2) consisted of 330 participants recruited from November 2022 to January 2023. From the original samples, one participant in Sample 2 did not complete the survey; 20 participants in Sample 1 and 19 participants in Sample 2 completed the survey in an implausibly short amount of time (220 questions in less than 5.5 min); and 55 participants in Sample 1 and 26 participants in Sample 2 failed to answer every question of the executive function scale, which was required in factor analysis. As such, all these individuals were excluded from the final samples. The demographic information of the final samples is presented in Table 2. The measurement models for the study were generated for two samples to increase cross-validity. When examining the associations between EF, ADHD and CDS, the two samples described were combined as there was no observed behavioral difference between them. Among the 608 participants, aged 17–69 years ($M = 23.0$, $SD = 8.3$), 143 (23.5%) self-identified as men, 459 (75.5%) self-identified as women and 6 (1.0%) self-identified as others. There were 52 participants (8.6%) reporting a prior diagnosis of ADHD.

Data for this study were from a larger project in which participants completed an online survey on the Redcap platform (Harris et al., 2009) and an online computer task. Only the data from the scale measuring executive functioning in daily life and basic demographic information such as age and gender were used for this study.

Table 2. Demographic information of the two samples (self-reported).

	Sample 1 (N_1 = 324)	Sample 2 (N_2 = 284)
Gender		
Men	67 (20.7%)	76 (26.8%)
Women	254 (78.4%)	205 (72.2%)
Others	3 (0.9%)	3 (1.1%)
Age (year)		
Range	17–56	17–69
Mean (*SD*)	20.5 (5.5)	25.9 (9.9)
Participants reporting a prior diagnosis of ADHD	30 (9.3%)	22 (7.7%)

Measures

The Barkley Deficits in Executive Functioning (BDEFS) long and short-form scales

The long-form BDEFS is an 89-item questionnaire comprised of five subscales measuring self-management of time, self-organization and problem solving, self-motivation, self-restraint (inhibition), and self-regulation of emotion respectively (e.g., "Procrastinate or put off doing things until the last minute" as a question for self-management of time, and "Have trouble calming myself down once I am emotionally upset" for emotion regulation, Barkley, 2011b). The short-form BDEFS is a 20-item self-report assessment derived from the long-form (Barkley, 2011b). Both the long and the short-forms utilize a Likert scale ranging from *never or rarely* (1) to *very often* (4). Composite scores were formed by averaging the relevant items, with higher scores indicating more EF difficulties (Barkley, 2011b). In the current study, internal consistency (Cronbach's α) was above .89 (from .89 to .95) for each subscale of the long-form in both samples. Cronbach's α's for the short form was reported in Results. The participants completed BDEFS long form in the survey. After the survey, the responses to the questions forming BDEFS short form were extracted and used to obtain the short-form subscale scores.

The Barkley Adult ADHD Rating Scale-IV (BAARS-IV)

ADHD symptoms were measured using the Inattention and Hyperactivity/impulsivity Subscales (Barkley, 2011a). These scales have been widely used in measuring ADHD symptoms both in clinical and general populations (e.g., Barkley, 2012; Jarrett et al., 2017; Kamradt et al., 2014). Both subscales are nine-item, 4-point Likert scales with response options ranging from *never or rarely* (1) to *very often* (4). Composite scores were formed by summing the relevant items, with higher scores indicating more symptoms. Items measuring inattention were summed separately from items for hyperactivity/impulsivity. In the current combined sample, the internal consistency (Cronbach's α) was 0.87 for the inattention subscale, and 0.80 for the hyperactivity/impulsivity subscale.

CDS was measured using The Barkley Adult ADHD Rating Scale-IV (BAARS-IV) SCT Subscale (Barkley, 2011a). It measures the core symptoms of CDS, including drowsiness, spacing out, a confused mind, and a daydreaming tendency (Barkley, 2011a). It is a nine-item, 4-point Likert scale with response options ranging from *never or rarely* (1) to *very often* (4) has been widely used in describing CDS symptoms (e.g., Barkley, 2012; Collado-Valero et al., 2021; Flannery et al., 2017). Composite scores were formed by summing all items, with higher scores indicating more symptoms. Its internal consistency (Cronbach's α) was .84 in the current combined sample.

Depression Anxiety Stress Scale-21 (DASS-21) for controlled variables

Negative affect (depression and anxiety) were measured using the depression and anxiety subscales of the Depression Anxiety Stress Scale-21 (DASS-21, Lovibond & Lovibond, 1995). Both subscales have seven items each using a 4-point Likert scale, extending from *did not apply to me at all* (0) to *applied to me very much or most of the time* (3). Higher scores indicate higher level of depression or anxiety. Consistent with the norms of the scales, the composite score for each subscale was obtained by summing all items of the subscale, and then multiplying by two (Lovibond & Lovibond, 1995). In this study, the internal consistency (Cronbach's α) was .91 for the depression subscale and was .84 for the anxiety subscale in the combined sample.

Statistical analyses

The analyses were conducted in two stages. First, Confirmatory Factor Analysis (CFA) was used to generate four models: a one factor model where all items loaded on a single general factor, a correlated five-factor model, a second-order model with five factors as indicators of a latent general EF factor, and a bifactor model (Figure 1). The analyses were conducted separately for Samples 1 and 2, using IBM SPSS Amos© v29 (IBM Corporation). CFA was used only, as the multidimensional nature of both the short and long form of the BDEFS has been established in previous research (Hernandez-Vallant et al., 2025; Kamradt et al., 2021; Kim et al., 2019; Lace et al., 2022). Measurement invariance between samples for the best fitting model was evaluated.

The models were generated using a maximum likelihood estimation procedure and fit was estimated using the Tucker-Lewis (TLI), comparative fit (CFI) indices, root mean square residual (RMR) and root mean square error of approximation (RMSEA). Model fit is considered satisfactory when $\chi^2/df < 3$, CFI > 0.90, TLI > 0.90, and the RMR and RMSEA < 0.08 (Kyndt & Onghena, 2014). Comparative fit for model comparison used the Akaike information criterion (AIC) and the Bayesian Information criterion (BIC), each of which compared between models, accounting the number of parameters used. A lower absolute value for each indicates a better fit (Akaike, 1974; Schwarz, 1978). Multi-group CFA was used to evaluate measurement invariance across the two samples, gender and age-group, in the correlated five-factor model. Three measurement invariance models were tested. First, we tested configural invariance, which allowed all parameters to vary freely. Second, metric invariance was tested by constraining the factor loadings across samples to be equal. Finally, scalar invariance was tested by constraining both factor loadings and intercepts to be equal across samples (Putnick and Bornstein, 2016). Measurement equivalence was tested using the χ^2 difference test, and the absolute change in the RMSEA and CFI of less than .01 indicates invariance (Rutkowski and Svetina, 2014).

At stage 2, one overall sample was generated to assess the associations between the short- and long-form subscales and to determine if the associations between EF difficulties and symptoms of ADHD and CDS differed when using the short- or the long-form subscales. Further, standard multiple regression analyses were conducted to investigate the unique contributions of ADHD and CDS symptoms to EF scores using each of the BDEFS short- and long-form subscale scores as separate outcome variables when controlling for depression and anxiety, which was consistent with previous studies (Fredrick & Becker, 2021; Jarrett et al., 2017; Wood et al., 2017). The results when using the short- or the long-form subscales were then compared. These analyses were conducted using IBM SPSS© v29 (IBM Corporation).

Results

Model estimation and sample comparison

The fit statistics for the one-factor, correlated five-factor, second-order and bifactor models were generated for each sample (see Table 3). Except for the one-factor model, which showed a poor fit, all other models produced an adequate fit for both samples. Based on the RMR, TLI, CFI and RMSEA indices, the correlated five-factor model was as good as the second-order and bifactor models. However, the AIC and BIC were lower for both samples in the correlated five-factor model than in other models, indicating that this model had the best balance of fit and parsimony. In addition, the item loadings for the items on each factor of the correlated model were high, ranging from .60 to .82 in Sample 1 and .58 and .85 in Sample 2 (see Table 4). The correlations between the five factors were moderate or high, as shown in Table 5, ranging from .45 to .89 in Sample 1 and from .51 to .88 in Sample 2. The strongest association in each sample was between time management and motivation, and the weakest association was between motivation and emotion regulation. The internal consistency of each of the factors in both samples were high (all ≥ .76, Table 4).

Multi-group CFA was undertaken to evaluate measurement invariance of the two samples for the correlated five-factor model (see Table 6). The configural model with unconstrained parameters, produced a good fit. Both the metric and scalar invariance models which constrained first factor loadings and then additionally item intercepts showed evidence of equivalence. This was demonstrated by non-significant χ^2 difference tests (Measurement: $\Delta\chi^2$ (15) = 16.51, p = .349; Scalar: $\Delta\chi^2$ (15) = 5.39, p = .988) and changes in the RMSEA and CFI of less than .01. Based on these findings, the two samples were then combined to evaluate measurement invariance for gender and age-group.

Measurement invariance across gender and age-group

The correlated five-factor model produced an acceptable fit when evaluated separately for men and women (Table 7), as well as the model of configural invariance (Table 6). Equivalence was shown for both the metric and scalar invariance models (Table 6). For each of these models, the χ^2 difference tests were non-significant, (Measurement: $\Delta\chi^2$ (15) = 15.82, p = .387; Scalar: $\Delta\chi^2$ (15) = 24.73, p = .054) and changes in the RMSEA and CFI were less than .01. These findings show measurement invariance for gender on the five-factor short form of the BDEFS.

Two age groups were generated to evaluate BDEFS of the influence of age. Consistent with the age-groupings generated by Kamradt et al. (2021), there were a group aged below 20 years and a group aged 20 years or older. An acceptable model fit was obtained for each age-group, for the separate correlated five-factor models (Table 7) and the model of configural invariance (Table 6). In addition, equivalence was shown for both the metric and scalar invariance models (Table 6). For each of these models, the χ^2 difference tests were non-significant, (Measurement: $\Delta\chi^2$ (15) = 20.74, p = .145; Scalar: $\Delta\chi^2$ (15) = 17.29, p = .302) and changes in the RMSEA and CFI were less than .01.

Overall, these results show that the correlated five-factor model provides the best balance of fit and parsimony to the data for the short-form BDEFS. The two samples used, together with gender and age-group showed evidence of measurement invariance, supporting the multidimensional structure of the short-form BDEFS. To determine whether the short-form factors provided an adequate representation of the long-form BDEFS, the associations between the short- and long-form subscales were obtained.

Associations between short-form and long-form BDEFS subscale score

The descriptive statistics and correlations between each short-form subscale score and its counterpart in the long-form were significant (p < .001) and high (from .89 to .93, Table 8) with a narrow 95% CI. Each short-form subscale score shared 79% to 86% variance with its long-form counterpart, highlighting the similarity of the scores derived from the two formats.

In summary, these results provide substantive evidence of the potential viability of the short-form EF subscales used in research. To evaluate the predictive validity of the short form subscales, the following analyses investigated the associations between the short and long forms, and the similarities between the two forms when investigating the unique associations between each EF subscale and both ADHD and CDS when controlling for negative affect.

Associations of short- and long-form BDEFS deficit subscales with ADHD, CDS

The correlations between each BDEFS subscale and symptoms of ADHD, CDS, and negative affect were positive and strong (see Table 9). Further, in most cases, the analogous correlations from using the short- versus the long-form BDEFS subscales were similar. This was demonstrated by the overlapping 95% CI of the correlation coefficients. The only differences were that the correlations between the short-form organizational skills and motivation subscales and ADHD inattention and CDS were marginally weaker than those generated by the long-form subscales. Also, the positive correlation between CDS and ADHD inattention, and the correlation between CDS and negative affect were positive and strong.

Unique contributions of ADHD, CDS, to short- and long-form BDEFS subscale scores, controlling for negative affect

Findings from the series of standard multiple regression analyses (see Table 10), found that symptoms of ADHD inattention, ADHD hyperactivity/impulsivity, and CDS, explained significant variance in each of the five short- and five long-form EF subscale scores. When comparing the size of the standardized regression coefficients in each model for the short- relative to the parallel long-form subscales, the coefficients for symptoms of CDS, and ADHD did not differ (with the 95% CI overlapping on all coefficients). In addition, the unique contributions of ADHD inattention and CDS on all subscales, and that of other variables on most subscales, were both significant or both non-significant (at p = .05 level) for the short and long-forms.

Importantly, the same pattern of results was obtained for each of the short and long-form subscales of the BDEFS, when uniquely predicted by symptoms of ADHD and CDS. Except for emotion regulation, ADHD inattention made significant unique contributions to the explanation of other EF subscales, with the strongest effects found for time management and motivation. With the exception of self-restraint (inhibition), CDS made significant unique contributions to the explanation of other EF subscales, with the strongest effects found for organization. ADHD hyperactive/impulsive

Table 3. Fit of the one-factor model, correlated five-factor, second-order, and bifactor model in the two samples (N_1 = 324, N_2 = 284).

	No. parameters	χ^2 (*df*)	χ^2/df	RMR	TLI	CFI	RMSEA (90% CI)	AIC	BIC
One-factor model	40								
Sample 1		825.2 (170)***	4.85	.073	.74	.76	.109 (.102–.117)	905.2	1056.5
Sample 2		773.2 (170)***	4.55	.071	.74	.77	.112 (.104–.120)	853.2	999.1
Correlated five-factor model	50								
Sample 1		328.4 (160)***	2.05	.044	.93	.94	.057 (.048–.068)	428.4	617.4
Sample 2		326.2 (160)***	2.04	.043	.93	.94	.061 (.051–.070)	426.2	608.7
Second-order model									
Sample 1	45	373.5 (145)***	2.26	.052	.91	.93	.063 (.054–.071)	463.5	633.6
Sample 2		376.2 (145)***	2.28	.051	.91	.92	.067 (.058-.076)	466.2	630.4
Bifactor model	60								
Sample 1		314.0 (150)***	2.09	.045	.93	.94	.058 (.049–.067)	434.0	660.9
Sample 2		341.7 (150)***	2.28	.047	.91	.93	.067 (.058–.077)	461.7	680.6

***p < .001. *Note*. RMR: root mean square residual; TLI: Tucker-Lewis index; CFI: comparative fit index; RMSEA: root mean square error of approximation; AIC: Akaike information criterion (lower values indicate better model fit); BIC: Bayesian information criterion (lower values indicate better model fit).

Table 4. Standardized factor loadings of all items in the correlated five-factor model of the short-form BDEFS.

		Sample 1 (N_1 = 324)					Sample 2 (N_2 = 284)				
		Time	Organization	Inhibition	Motivation	Emotion	Time	Organization	Inhibition	Motivation	Emotion
1	Procrastinating	.61					.64				
2	Failing to hold in mind things to do	.57					.67				
3	Problem with motivation in preparation	.69					.76				
4	Trouble telling myself to do things	.76					.73				
5	Less capable of learning new/ complex activities than others		.71					.75			
6	Trouble explaining things in order		.67					.69			
7	Incapable of thinking on my feet		.61					.66			
8	Slower and less accurate in information procession than others		.79					.78			
9	Inhibition problems			.64					.72		
10	Impulsive commenting			.69					.65		
11	Unlikely to consider consequences			.67					.68		
12	Acting without thinking			.76					.66		
13	Less effortful than expected or than others				.77					.66	
14	Appraised as lazy or unmotivated				.60					.58	
15	Inconsistent in work performance				.77					.80	
16	Needing more supervision or instruction than others				.66					.71	
17	Difficult to calm down when upset					.87					.85
18	Difficult to regain emotional control					.75					.79
19	Incapable of self-distracting and refocus when upsetting					.80					.74
20	Remaining emotional longer than others					.76					.76
Internal consistency (Cronbach's α)		0.79	0.81	0.77	0.76	0.85	0.79	0.81	0.78	0.78	0.86

Note. BDEFS subscales: Time: self-management of time, Organization: self-organization and problem-solving, Motivation: self-motivation, Inhibition: self-restraint (inhibition), and Emotion: self-regulation of emotion.

Table 5. Correlations between factors in the correlated five-factor model of BDEFS short form (the data above the diagonal line were obtained using Sample 1 [N_1=324], and those below the diagonal line were obtained using Sample 2 [N_2 = 284]).

	Time	Organization	Inhibition	Motivation	Emotion
Time		.76	.58	.87	.58
Organization	.75		.72	.78	.56
Inhibition	.75	.67		.66	.62
Motivation	.88	.82	.77		.56
Emotion	.58	.63	.75	.51	

Note. Definitions of the factors: Time: self-management of time, Organization: self-organization and problem-solving, Motivation: self-motivation, Inhibition: self-restraint (inhibition), and Emotion: self-regulation of emotion.

explained significant unique variance in self-restraint (inhibition) and emotion regulation, with the strongest relative effect found for self-restraint. These findings show the importance of investigating the individual components of functional EF when evaluating the patterns of difficulty related to different attentional difficulties. They also provide further support for the five-factor structure of the short-form BDEFS and for the theoretically derived multidimensional nature of EF.

Discussion

The goal of the current research was to investigate the internal and predictive validity of the short-form BDEFS subscales. Notably, this study was the first to utilize Australian samples, with a wide age range, to validate the five-factor model of the short-form BDEFS, and test measurement invariance across samples, gender and age-group, while also exploring its attributes and application to attention difficulties. Overall, the results suggest that the five-factor structure found for the short-form BDEFS does not substantially differ from the long-form BDEFS five-factor structure found in past research (Wood et al., 2017). Strong positive correlations were observed between the subscales of the short- and the long-form, reinforcing their lack of substantial difference. Furthermore, based on associations of the symptoms of CDS and ADHD, with the five EF deficit subscales, the short-form subscales were valid and showed little difference in their predictive validity when compared to the long-form. Thus, it appears that the multiple dimensions of EF crucial for effective daily functioning can be validly and reliably assessed using the BDEFS short form.

Using CFA, the factor structure of the short-form BDEFS subscales was investigated. Consistent with previous studies (Hernandez-Vallant et al., 2025; Kim et al., 2019; Lace et al., 2022), the results provided strong support for the five-factor

Table 6. Measurement invariance tests across samples, gender, and age-group.

	χ^2 (*df*)	χ^2/df	RMR	TLI	CFI	RMSEA (90% CI)	ΔRMSEA	ΔCFI
Sample 1 vs. Sample 2								
Full sample	654.6 (320)***	2.05	.043	.93	.94	.042 (.037–.046)		
Metric invariance	671.1 (335)***	2.00	.048	.93	.94	.041 (.036–.045)	.001	.000
Scalar invariance	676.5 (350)***	1.93	.049	.93	.94	.039 (.035–.044)	.002	.001
Gender								
Full sample	630.4 (320)***	1.97	.047	.93	.94	.040 (.036–.045)		
Metric invariance	646.3 (335)***	1.93	.051	.93	.94	.039 (.035–.044)	.001	.000
Scalar invariance	671.0 (350)***	1.92	.076	.93	.94	.039 (.035–.044)	.001	.002
Age-group								
Full sample	655.6 (320)***	2.05	.044	.93	.94	.042 (.037–.046)		
Metric invariance	676.4 (335)***	2.02	.049	.93	.94	.041 (.037–.045)	.001	.001
Scalar invariance	693.7 (350)***	1.98	.052	.93	.94	.040 (.036–.045)	.001	.001

****p* < .001. *Note*. RMR: root mean square residual. TL: Tucker-Lewis index. CFI: comparative fit index. RMSEA: root mean square error of approximation. ΔRMSEA: changes in RMSEA between nested models (changes < .01 support measurement invariance). ΔCFI: changes in CFI between nested models (changes < .01 support measurement invariance). *p* > .05 for all Chi-square difference tests.

Table 7. Fit indices across gender and age-group.

	χ^2 (*df*)	χ^2/df	RMR	TLI	CFI	RMSEA (90% CI)	AIC	BIC
Gender								
Men (*n* = 143)	262.2 (160)***	1.64	.055	.89	.91	.067 (.052–.080)	362.2	510.3
Women (*n* = 459)	368.2 (160)***	2.30	.037	.94	.95	.053 (.046–.060)	468.2	674.7
Age-group								
Younger (<20 years, *n* = 300)	340.5 (160)***	2.13	.045	.92	.93	.061 (.052–.070)	440.5	625.7
Older (≥20 years, *n* = 308)	315.1 (160)***	1.97	.043	.94	.95	.056 (.047–.065)	415.1	601.6

****p* < .001. *Note*. RMR: root mean square residual. TLI: Tucker-Lewis index. CFI: comparative fit index. RMSEA: root mean square error of approximation. AIC: Akaike information criterion (lower values indicate better model fit). BIC: Bayesian information criterion (lower values indicate better model fit).

Table 8. Bivariate Pearson correlations with 95% CI between each short-form and long-form BDEFS subscale score.

	M (*SD*) of short-form BDEFS subscale score		*M* (*SD*) of long-form BDEFS subscale score		Correlations between the short-form and the long-form subscale	
	Sample 1 (*N* = 324)	Sample 2 (*N* = 284)	Sample 1 (*N* = 324)	Sample 2 (*N* = 284)	Sample 1 (*N* = 324)	Sample 2 (*N* = 284)
Time	2.62 (0.71)	2.29 (0.76)	2.40 (0.65)	2.07 (0.67)	.92 [.90 .94]***	.92 [.91 .93]***
Organization	2.07 (0.72)	1.88 (0.74)	2.26 (0.64)	2.05 (0.63)	.89 [.87 .91]***	.90 [.88 .92]***
Motivation	1.99 (0.69)	1.77 (0.66)	2.04 (0.59)	1.86 (0.57)	.89 [.87 .91]***	.89 [.88 .91]***
Inhibition	2.10 (0.77)	1.81 (0.70)	2.18 (0.68)	1.91 (0.63)	.91 [.89 .93]***	.91 [.90 .92]***
Emotion	2.29 (0.86)	2.09 (0.80)	2.24 (0.71)	2.08 (0.70)	.93 [.91 .94]***	.93 [.92 .94]***

****p* < .001. *Note*. BDEFS subscales: Time: self-management of time, Organization: self-organization and problem-solving, Motivation: self-motivation, Inhibition: self-restraint (inhibition), and Emotion: self-regulation of emotion.

structure in four key ways. First, the correlated five-factor model was among the best-fitting models for the data of both samples, and compared with other models that also fit, it provided the most parsimonious explanation. Second, this model was further supported by the good internal consistency of each subscale, and the high loading of each item on the corresponding factor. Third, measurement invariance was found across samples, gender and age-group, demonstrating the stability of the model. Finally, the correlations between the subscales varied, indicating that they measure distinct and meaningful constructs, not a unitary construct. Critically, these results are consistent with the theoretical underpinnings of the functional EF scale (Barkley, 2011b; Kamradt et al., 2021). The correlated five-factor model directly reflects the distinct theoretical dimensions of executive functioning measured by the scale (Barkley, 2011b). Together these findings support the viability of using the individual subscale scores when administering the short-form BDEFS.

Notably, the results did not support a strong general factor, which was different from the findings of Clauss et al. (2021) and Hernandez-Vallant et al. (2025). First, the one-factor model was a poor fit. Second, the bifactor model did not provide a better fit than the more parsimonious correlated five-factor model driven by theories of EF. Considering the bias favoring bifactor models in statistical analysis (Bonifay et al., 2017; Gignac, 2007; Murray & Johnson, 2013; Raftery, 1995; Rodriguez et al., 2016), these results indicate that the bifactor model was not clearly superior to the correlated five-factor model. Indeed, it should also be noted that the statistical results of the CFA serve as one of the criteria and should be interpreted in conjunction with other data analyses and theoretical considerations (Bonifay et al., 2017; Murray & Johnson, 2013; Rodriguez et al., 2016). In addition, the correlations between the short- and long-form BDEFS subscales were all very high, providing additional support for the robustness of the subscale structure of the short form. Taken together, this study supported the internal validity of the subscale structure of the short-form BDEFS.

In addition to supporting the five-factor structure of the short-form BDEFS, the current study was the first to demonstrate that both the short- and long-form subscales produced similar and strong bivariate correlations with symptoms of CDS, ADHD inattention, and ADHD hyperactivity/impulsivity (with overlapping 95% CI in most cases). Moreover, this study was the first to show that the unique contributions of

Table 9. Correlations with 95% CI between short- and long-form BDEFS deficit subscales, and symptoms of CDS, ADHD, and negative affect ($N=608$).

	CDS	INA	HYP/IMP	Depression	Anxiety
Time (short)	.66 [.61 .70]	.71 [.67 .75]	.49 [.43 .55]	.48 [.42 .54]	.44 [.38 .50]
Time (long)	.69 [.65 .73]	.76 [.73 .79]	.53 [.47 .59]	.53 [.47 .59]	.50 [.44 .56]
Organization (short)	.67 [.62 .71]	.64 [.59 .68]	.43 [.36 .49]	.44 [.37 .50]	.50 [.44 .56]
Organization (long)	.76 [.73 .80]	.74 [.70 .77]	.54 [.48 .59]	.54 [.48 .60]	.57 [.52 .62]
Motivation (short)	.51 [.45 .57]	.58 [.52 .63]	.62 [.57 .67]	.42 [.35 .48]	.42 [.35 .48]
Motivation (long)	.63 [.58 .67]	.69 [.65 .73]	.67 [.62 .71]	.51 [.45 .57]	.53 [.47 .59]
Inhibition (short)	.63 [.58 .68]	.65 [.60 .70]	.43 [.37 .50]	.50 [.44 .56]	.47 [.41 .53]
Inhibition (long)	.68 [.63 .72]	.72 [.68 .76]	.51 [.45 .57]	.54 [.48 .60]	.50 [.44 .56]
Emotion (short)	.56 [.51 .61]	.51 [.45 .56]	.49 [.42 .55]	.53 [.47 .58]	.56 [.50 .61]
Emotion (long)	.61 [.56 .66]	.57 [.52 .62]	.54 [.48 .60]	.56 [.50 .61]	.59 [.53 .64]
INA	.77 [.73 .80]				
HYP/IMP	.55 [.50 .61]	.68 [.63 .72]			
Depression	.58 [.53 .63]	.45 [.38 .51]	.33 [.26 .40]		
Anxiety	.54 [.48 .59]	.49 [.42 .55]	.47 [.40 .53]	.66 [.61 .70]	
M (*SD*)	18.88 (5.84)	16.37 (5.82)	16.82 (5.30)	13.93 (11.23)	13.39 (10.32)

All $p < .001$. *Note*. BDEFS subscales: Time: self-management of time, Organization: self-organization and problem-solving, Motivation: self-motivation, Inhibition: self-restraint (inhibition), and Emotion: self-regulation of emotion. CDS: BAARS SCT subscale score; INA: BAARS inattention subscale score; HYP/IMP: BAARS hyperactivity/impulsivity subscale score. The possible range of scores for CDS; INA and HYP/IMP were 9 to 36, and for depression and anxiety were 0–42.

Table 10. Regressing BDEFS short- and long-form subscales on ADHD inattention, hyperactivity/impulsivity, CDS, depression and anxiety ($N=608$, $df=5$).

	β [95% CI]					
	Time		Organization		Inhibition	
	Short-form	Long-form	Short-form	Long-form	Short-form	Long-form
CDS	0.20 [0.11–0.29]***	0.14 [0.06–0.22]***	0.39 [0.29–0.48]***	0.38 [0.30–0.46]***	0.04 [−0.06–0.14]	0.08 [−0.01–0.16]
INA	0.49 [0.40–0.59]***	0.56 [0.47–0.64]***	0.32 [0.22–0.42]***	0.34 [0.26–0.42]***	0.19 [0.08–0.29]***	0.28 [0.19–0.37]***
HYP/IMP	0.00 [−0.07–0.08]	0.00 [−0.07–0.07]	−0.08 [−0.16 – 0.01]*	0.01 [−0.06–0.07]	0.41 [0.33–0.50]***	0.34 [0.27–0.41]***
Depression	0.14 [0.07–0.22]***	0.17 [0.10–0.24]***	−0.04 [−0.12–0.04]	0.06 [0.00–0.13]	0.18 [0.09–0.26]***	0.18 [0.11–0.25]***
Anxiety	0.00 [−0.08–0.08]	0.04 [−0.03–0.11]	0.20 [0.12–0.28]***	0.16 [0.09–0.22]***	0.00 [−0.09–0.08]	0.08 [0.00–0.15]*
ΔR^2	53.6%	62.6%	51.3%	65.4%	46.2%	59.9%
$\Delta R^2_{Adjusted}$	53.3%	62.2%	50.9%	65.1%	45.7%	59.5%
ΔF	139.3***	201.1***	126.8***	227.1***	103.2***	179.6***

	β [95% CI]			
	Motivation		Emotion	
	Short-form	Long-form	Short-form	Long-form
CDS	0.20 [0.10–0.30]***	0.17 [0.08–0.26]***	0.21 [0.11–0.32]***	0.21 [0.12–0.31]***
INA	0.43 [0.32–0.53]***	0.47 [0.38–0.56]***	0.02 [−0.08–0.13]	0.07 [−0.03–0.17]
HYP/IMP	−0.05 [−0.13–0.03]	0.01 [−0.06–0.09]	0.19 [0.11–0.27]***	0.21 [0.14–0.29]***
Depression	0.17 [0.09–0.25]***	0.20 [0.12–0.27]***	0.18 [0.10–0.27]***	0.19 [0.11–0.27]***
Anxiety	0.07 [−0.01–0.15]	0.04 [−0.03–0.12]	0.22 [0.14–0.31]***	0.21 [0.13–0.29]***
ΔR^2	47.9%	59.2%	41.6%	49.1%
$\Delta R^2_{Adjusted}$	47.4%	58.8%	41.1%	48.7%
ΔF	110.6***	174.5***	85.7***	116.0***

*$p < .05$; **$p < .01$; ***$p < .001$. *Note*. BDEFS subscales: Time: self-management of time, Organization: self-organization and problem-solving, Motivation: self-motivation, Inhibition: self-restraint (inhibition), and Emotion: self-regulation of emotion. CDS: BAARS SCT subscale score, INA: BAARS inattention subscale score, HYP/IMP: BAARS inattention hyperactivity/impulsivity subscale score.

ADHD, CDS on a short-form BDEFS subscale and its long-form counterpart had the same pattern and were similar with overlapping 95% CI in all cases. In addition, these findings, when using the long or the short-form, both largely replicated a previous study that used only the long-form subscales and an undergraduate sample with a gender composition similar to this study (Wood et al., 2017). Of note, whereas we did not find a unique contribution of CDS on self-restraint (inhibition), Wood et al. (2017) did (however, this effect was weak). Our non-significant result, which occurred only after controlling for depression and anxiety, is consistent with other studies that have found no significant relationship between CDS and self-restraint (inhibition) (Barkley et al., 2022).

Taken together, these results support the predictive validity of the short-form BDEFS subscales and are consistent with the theoretical multidimensional nature of EF (Barkley, 2012; Barkley & Murphy, 2011; Schachar and Crosbie, 2024). Although the short-form BDEFS was originally recommended for use as a single measure incorporated with a clinical interview (Barkley, 2011b), the present study demonstrates the efficacy of using the short-form subscales in research. Importantly, this conclusion is based on the empirical results obtained in the current study, as well as theoretical explanations of functional EF as a multidimensional construct (Barkley, 2011b; Barkley & Murphy, 2011; Diamond, 2013; Willcutt et al., 2005). Consistent with previous studies using similar samples and the long-form BDFS, relatively stronger effects of ADHD inattention were found for motivation and time management, with CDS most strongly associated with organization and emotion regulation and ADHD hyperactivity/impulsivity most strongly associated with self-restraint. These findings are consistent with other studies that have investigated the unique impacts of ADHD and CDS of the different functional components of EF in adults (Barkley et al. 2022; Jarrett et al., 2017; Wood et al., 2017). In contrast to these findings, when using the overall score of the short-form BDEFS to represent the EF deficits, both CDS and ADHD inattention demonstrated unique positive contributions and were not differentiable (Flannery et al., 2017). Therefore, the intrinsic cognitive difference of the two attention/concentration difficulties was only uncovered by the utilization of the short-form subscales suggesting that the short form can be effectively used when investigating EF deficits among different populations.

EF deficits can disrupt critical cognitive processes such as planning, organization, task initiation, and sustained effort, leading to decreased efficiency, increased frustration, and difficulties in fulfilling demands across multiple domains, significantly undermining an individual's ability in diverse activities (Allee-Smith et al., 2013; Barkley & Murphy, 2011; Bikic et al., 2017; Diamond, 2013; Etnier & Chang, 2009; Spiegel et al., 2021; Stern et al., 2017; Willcutt et al., 2005; Wood et al., 2017). For example, deficits in EF largely explained poor academic outcomes for students with ADHD in higher education (DuPaul et al., 2021; Weyandt et al., 2017). The different EF profiles found among university students in this and previous studies, combined with the high prevalence of attentional difficulties (ADHD and CDS) among this population, highlight the need for fast and effective methods to assess the predominant types of EF impairments experienced by these individuals (Barkley, 2012; Becker, 2025; Biederman et al., 2010; Faraone et al., 2006; Lara et al., 2009; Wood et al., 2017). Use of the short form of the BDEFS would enable clinicians to pinpoint the most impaired components of EF in an efficient and reliable manner. This could enable interventions tailored to the needs of individual students, thereby enhancing their capacity to successfully complete university studies.

Limitations and future directions

One important limitation of the current findings are the strong associations found between each of the short-form subscales. These were similar to those found for the more established long form in the current study and previous research (Jarrett et al., 2017). There has been considerable argument in the literature concerning an underlying, goal related behavioral construct, similar to "g," as an explanation of executive function (e.g., Jurado & Rosselli, 2007). Further investigation of the dimensionality of each of the short and long forms of the scale may be warranted as suggested by Clauss et al. (2021).

Although the study was one of the first to demonstrate the utility of the subscales of the BDEFS short-form, future research could extend the present studies in multiple ways. First, the present study chose an undergraduate sample to control for the potential confounding impact of general cognitive ability on EF (Mahone et al., 2002; Salthouse, 2005). However, future studies could replicate the present studies in more demographically diverse sample. Given the potential negative impact of ADHD and CDS symptoms and EF deficits on academic performance (Barkley, 2012; Bauermeister et al., 2012; Becker et al., 2014, 2022; Flannery et al., 2017; Fredrick & Becker, 2023; Wang et al., 2025), individuals with a more diverse education background would constitute more representative samples of the general population and could show evidence of a wider range of EF difficulties. Second, future studies could also investigate the relationship between the short-form BDEFS subscale scores and performance of functional EF tasks. Previous studies have predominantly examined the associations between BDEFS scores and EF performance on traditional laboratory tasks, which have produced mixed findings, suggesting that the functional components of EF assessed with the BDEFS and laboratory based neuropsychological tasks measure different aspects of EF (Barkley, 2012; Barkley et al., 2022; Barkley & Murphy, 2011; Jarrett et al., 2017). Employing functional EF tasks such as Weekly Calendar Planning Activity (WCPA, Toglia, 2015) and BDEFS in the same study and investigating their associations could provide greater insights into the ecological validity of the short-form BDEFS.

Conclusion

The current study provided evidence of the internal and predictive validity of the short-form BDEFS by demonstrating that: (1) the five-factor model corresponding to the five subscales fit well and produced the most parsimonious explanation for the scale; (2) the short-form subscales correlated strongly with the long-form subscales; (3) the short- and long-form subscales showed similar correlations with CDS, ADHD inattention and hyperactivity/impulsivity; and (4) CDS had similar unique contributions on BDEFS subscales of both forms and so did ADHD inattention, and these contributions were also consistent with a previous study using the complete long-form BDEFS and similar research design (Wood et al., 2017). The long-form BDEFS has been used to assess EF in the research of ADHD and CDS and has contributed to our understanding of the two difficulties (Barkley, 2012; Jarrett et al., 2017; Wood et al., 2017). As such, it can be concluded that a shorter, simpler form of EF scale could facilitate EF assessment in future research in these areas, as it is more time efficient for administration and has only one version. More application of the short-form BDEFS would promote understanding of functional impairments the individuals with ADHD, CDS or both experience and contribute to their intervention in practice.

Ethical approval

Griffith University ethic approval was obtained prior to this study.

Informed consent

Electronic informed consent from every participant was obtained before participation.

Disclosure statement

No potential conflict of interest was reported by the author(s).

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Data availability statement

The datasets generated during and analyzed during the current study are available in the figshare repository. Private sharing link: https://figshare.com/s/90d2a03189c7ef774160. Public sharing link: https://doi.org/10.6084/m9.figshare.27266265.v2.

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