

The Chinese Version of the Compensatory ADHD Behaviors Scale (CABS): A Study on Reliability, Validity, and Clinical Utility

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Purpose: With the further development of attention-deficit/hyperactivity disorder (ADHD) research, more and more assessment tools related to ADHD have been used. However, there is still no measurement instrument to evaluate the compensatory behavior of ADHD in China. This study aimed to examine the reliability and validity of the Compensatory ADHD Behaviors Scale (CABS) adapted in Chinese and explore ecological characteristics in adults with ADHD using the CABS.

Patients and Methods: Data were collected from a sample of 306 adults ($M_{\text{age}} = 26.43$ years, $SD = 5.32$; 46.08% male). The original version CABS was translated into Chinese using the forward and backward translation procedures. Participants completed the CABS and questionnaires assessing ADHD symptoms and executive function. We utilized content validity, exploratory factor analysis (EFA), confirmatory factor analysis (CFA), and criterion validity to test the validity. Internal consistency and test-retest reliability were employed to test the reliability. Analysis of variance (ANOVA) was employed to compare ADHD subgroups based on gender, ADHD subtype, comorbidities, and medication status, while controlling for demographic variables as covariates.

Results: CABS exhibited good construct validity (two factors: present-oriented and future-oriented), content validity (content validity index: 0.98), internal consistency reliability (Cronbach's alpha coefficient: 0.85 to 0.87) and test-retest reliability (intraclass correlation coefficient: 0.59 to 0.88). The results of CFA showed acceptable fitness for each subscale. CABS demonstrated significant associations with inattention symptoms and plan/organizational abilities. Medicated ADHD individuals scored higher on future-oriented effectiveness subscale of CABS than non-medicated ($F = 6.106$, $p = 0.014$).

Conclusion: The results indicate that the Chinese CABS exhibited good validity and reliability. It can be considered a valid tool for assessing compensatory behaviors in Chinese adults with ADHD. Further research is needed to explore the connection between medication and compensatory behavior.

Keywords: attention-deficit/hyperactivity disorder, adult, compensatory behaviors, reliability, validity, ecological characteristics

Introduction

Compensation is defined as an automatic and/or voluntary mechanism. Through this mechanism, the atypicality of genes, nerves, and cognition is offset by internal bodily processes and environmental factors, thereby covering atypical behaviors.¹ Compensation in neurodevelopmental disorders refers to the process of striving to improve behavioral performance despite core deficits at the cognitive and/or neurobiological level. The above definition illustrates that compensation may lead to a mismatch between explicit behavior and intrinsic cognition, therefore, performance of the compensatory could be better than expected based on its potential cognitive level.² Simply put, compensatory behaviors may cover up some underlying deficits or reduce the destructive consequences caused by core deficits.^{3,4}

Attention-deficit/hyperactivity disorder (ADHD) is widely regarded as a neurodevelopmental disorder associated with significant distress throughout the lifespan.⁵ ADHD often begins in childhood and is manifested as age-inappropriate

inattention, motor hyperactivity, and impulsivity.⁶ It is also known that the majority of children with ADHD experience motor skill problems.⁷ A recent study has shown that most children with ADHD still have residual symptoms in adulthood.⁸ Compared with healthy adults, adult ADHD has shown obvious deficiencies in many aspects such as organization, time management, activation work, as well as maintaining attention.^{9,10} It has also been suggested that adults with ADHD still underestimate the impact of ADHD symptoms, because they may have used compensatory strategies to overcome the negative influences of ADHD on daily life.¹¹ In addition, some studies believed that with age increase, hyperactivity symptoms gradually internalized, and inattention may be masked by compensatory behaviors. Therefore, the fully developed compensatory behaviors of ADHD patients at an early stage may also contribute to the delay in diagnosis.¹²

ADHD compensatory behaviors refers to environmental modifications and/or behavioral strategies used to overcome impairment associated with core symptoms.¹³ Previous studies have suggested that compensatory behaviors in individuals with ADHD were often used to compensate for inattention symptoms, while hyperactive/impulsivity symptoms may have a certain compensatory effect, aiding in the regulation of attention ability.^{13–15} In a qualitative study, Kysow et al found that most ADHD participants used at least one compensatory behavior, but some subjects did not adhere to it or found the strategy ineffective. More specifically, organizational strategies were identified as the most likely compensatory behaviors to either fail or not be adhered to.¹³ Another qualitative study also found that organizational behaviors were adults' most common compensatory behaviors prior to an ADHD diagnosis, including structured lists, reminder software, and secretary, which usually were applied to daily life and the workplace.¹⁶ This study also mentioned that compensatory social behaviors were manifested as deliberately arriving at the agreed place in advance and avoiding explicit commitments to others. On one hand, research has suggested that employing compensatory behaviors could assist ADHD patients in better gaining control over their lives. This was because ADHD patients often exhibited forgetfulness, procrastination, and disorganization, and implementing compensatory behaviors tailored to address these issues could help reduce anxiety and enhance productivity.¹⁷ On the other hand, some studies have found that certain ADHD patients described compensatory behaviors as “energy-consuming”, indicating that for some ADHD patients, these effortful strategies may lead to frustration and even exhaustion.¹⁸ Therefore, the impact of ADHD compensatory behaviors on individuals' lives remains inconclusive for now.

Furthermore, regarding the impact of gender on compensatory behaviors, previous research findings have been inconsistent. Some studies did not find differences in the use of compensatory behavior between different genders, but other studies believed that females with ADHD may be more adept at using compensatory behaviors, which may contribute to the underdiagnosis of female patients in clinical settings.^{13,19} In addition, it has been suggested that medication, as a treatment method with positive effects on the functioning of patients with ADHD, may help to reduce the use of compensatory behaviors, because medication may make it less urgent for ADHD patients to develop compensatory strategies.^{18,20,21} To date, there has been no research investigating the influence of comorbidities on compensatory behaviors in individuals diagnosed with ADHD. Since neurocognitive impairment is one of the core features of many mental disorders, whether the comorbidities of other mental disorders have a significant impact on compensatory behavior is also a direction that can be explored in the future.^{22,23}

Currently, the research on compensatory behavior is still limited by the lack of assessment tools. In previous studies, spontaneous reports and open questions were used to collect and classify compensatory behaviors.^{13,16} However, such qualitative studies cannot fully reflect the compensatory behaviors of ADHD patients and are not conducive to further academic research and communication. In 2019, in order to measure the compensatory behaviors in adult ADHD, Castagna et al developed then validated the Compensatory ADHD Behaviors Scale (CABS) in the USA.²⁴ Currently, there are no studies validating the reliability and validity of the CABS scale in other countries. The CABS contained a variety of organizational planning and behavioral management methods, which could be divided into two major modules. One module measured usefulness, that was, whether to use a particular compensatory behavior, and the other module measured effectiveness, that was, whether a particular compensation behavior was effective. The reliability and validity of the CABS were verified in the study, and exploratory factor analysis (EFA) was used to extract two factors, named present-oriented and future-oriented. Using the factor structure described, internal consistency with Cronbach's alpha of the use/effectiveness of the CABS ranged from 0.81 to 0.87. And the study also found that present-oriented, but

not future-oriented, compensatory behaviors were associated with ADHD symptoms, executive function (EF) deficits, and total functional impairment.²⁴

Although there is a pressing need for clinical and scientific research, there is still a lack of a self-report scale to evaluate compensatory behavior in ADHD population. The CABS is a convenient, non time-consuming, self-rated compensatory behavior scale. The primary objective of this study was to translate the CABS into Chinese, validate its reliability and validity within the Chinese population, and subsequently investigate the ecological characteristics of adults with ADHD using the CABS for the first time in China.

It should be noted that when validating the CABS, the influence of each country's ADHD characteristics should also be considered. According to previous studies, the prevalence of adult ADHD in the United States was approximately 2.5%–4.4%.²⁵ While there is currently no multicenter, unified standard epidemiological survey of adult ADHD in China, the latest research found that the prevalence of adult ADHD in China was around 3%.²⁶ Based on these results, we cautiously believed that the prevalence of ADHD in the two countries was similar for the time being, although this conclusion still requires further confirmation in the future. Additionally, the clinical characteristics of adult ADHD appeared to be similar in both countries.^{25,26} Therefore, it suggested that the ADHD characteristics arising from different countries may have a relatively minor impact on the validation of CABS reliability and validity. However, it cannot be denied that cultural differences, such as language expression, may affect the interpretation and application of the scale.²⁷ This factor should be carefully evaluated during the translation and cross-cultural adaptation of the scale.

Materials and Methods

Procedures

This study was approved by the Ethics Committee of the Peking University Sixth Hospital (protocol code: 2022–39), and all participants signed an informed consent form. And all methods were performed in accordance with the relevant guidelines and regulations or declaration of Helsinki.

The introduction of the CABS involved translation and cross-cultural adaptation, with specific steps outlined in the [Supplementary Materials](#). Through the above steps, the Chinese version of the CABS was formed.

All participants (n = 306) were required to complete the CABS and then were randomly divided into two groups. One part (n = 153) was analyzed for EFA, and the other (n = 153) was for confirmatory factor analysis (CFA). Besides, all participants also completed other scales and tests: ADHD Rating Scale (ADHD-RS), Behavior Rating Inventory of Executive Function-Adult Version (BRIEF-A), and Neuropsychological Assessment Battery: Mazes (Mazes). Part of the participants (n = 40) in the ADHD group were asked to fill out the CABS again after a 2-week interval to measure test-retest reliability.

Participants

The analysis included ADHD patients and healthy controls (HC) aged between 18 and 65 years. The ADHD patients were recruited in the outpatient of Peking University Sixth Hospital. The HC were recruited through the online platform. Specifically, this study utilized WeChat, a highly popular social application in China, for the recruitment of HC participants.²⁸ Participants in the ADHD group were assessed by a psychiatrist above the attending physician, met the DSM-5 criteria for adult ADHD diagnosis, and excluded those with current severe suicidal thoughts/behaviors or psychotic symptoms, those with current severe physical diseases, and those unable to cooperate with the study for other reasons. It should be noted that participants in the ADHD group were allowed to have comorbidity. The study screened a total of 238 subjects in the ADHD group, among whom 18 did not meet the ADHD diagnosis criteria, and 7 were unavailable to participate in the study. Eventually, the study included 213 ADHD subjects. Additionally, the inclusion criteria of the HC group were as follows: (1) assessed by a psychiatrist above the attending physician to ensure that there was no current or previous psychiatric disorder, (2) no family history of psychiatric disorder, and (3) no use of psychiatric medications. Severe physical illness and inability to conduct the study were also excluded. The study screened 98 subjects in the HC group, of whom 3 had a history of major depression disorder, and 2 were unable to participate in the study. Ultimately, the study included 93 healthy subjects.

Measures

Conners Adult ADHD Diagnostic Interview for DSM-IV (CAADID)

The semi-structured interview was a tool clinicians use to help diagnose ADHD based on DSM-IV diagnostic criteria. To obtain DSM-5 diagnoses of ADHD, the age of onset was changed from before the age of 7 to before the age of 12, and the number of symptoms required for an adult diagnosis was reduced from six to five in either inattention or hyperactivity-impulsivity domain.²⁹ Similar conversions have also been appeared in other studies as well.^{30,31}

Structured Clinical Interview for DSM-IV Axis I Disorders (SCID-I)

SCID-I estimated the current and previous mental state based on the DSM-IV diagnostic criteria.³²

CABS

CABS was a self-rating scale to measure compensatory behaviors in ADHD patients divided into two subscales: use and effectiveness. The compensatory behavior described in the subscale was a one-to-one correspondence, such as “I check things I have done to make sure I did not make a mistake (the use subscale)”, which corresponded to “Checking things helps me avoid making mistakes (the effectiveness subscale)”. The use subscale mainly assessed how often subjects used organize, plan, and manage behaviors, such as the use of calendars, schedules, or to-do lists in daily life and work tasks. The effectiveness subscale mainly assessed the degree to which subjects benefit from the compensatory behaviors described in the use subscale.

There were 28 items on the scale, and each subscale had 14 items. Each item was scored on a 5-point scale (0 point for “not at all” to 4 points for “often”). The score of use subscale was the sum of the first 14 items of the CABS, the score of effectiveness subscale was the sum of the last 14 items of the CABS, and the score of CABS was the sum of all items. CABS did not score in reverse. Higher scores indicated more use of compensatory behavior or more effective.²⁴

ADHD-RS

ADHD-RS was a self-rating scale that could describe ADHD symptoms. Inattention, hyperactivity/impulsivity, and total scores were calculated using a 4-point Likert scale. The higher the score, the more severe the symptoms.³³

BRIEF-A

BRIEF-A was composed of 75 questions classified under two indexes: behavioral regulation index (BRI) and metacognition index (MI). BRI included Inhibit, Shift, Emotional Control, and Self-Monitor. MI included Initiate, Working Memory, Plan/Organize, Organization of Materials, and Task Monitor. The higher the score, the more severe the EF impairment.³⁴ Two factors of Plan/Organize (PO) and Organization of Materials (OM) were used in this study.

Mazes

The Mazes was a neurocognitive test that measured reasoning and problem-solving. The score was calculated by the completion time, and the higher the score, the better the problem-solving ability.³⁵

Data Analysis

Continuous variables were expressed through mean (standard deviation) and categorical variables as percentages. All statistical results were tested by a two-sided test ($\alpha = 0.05$). Data were analyzed using SPSS Statistics (version 25; IBM) and SPSS Amos (version 25.0; IBM).

Content Validity

In the cross-cultural adaptation of the scale, the final Chinese version of CABS was estimated by the six experts of the expert committee to measure the content validity. The content validity index (CVI) was calculated on a 4-point scale (1: very irrelevant; 4: very relevant) to reflect whether the scale items reflected the measured concepts and whether they were readable.³⁶ CVI included item-level content validity (I-CVI) and average scale-level content validity (S-CVI/Ave). When there were more than six experts, the I-CVI should be ≥ 0.78 , considered a good I-CVI. The S-CVI/Ave should be ≥ 0.90 to be considered a good S-CVI.³⁷

Construct Validity

Data were randomly divided into two groups using random numbers generators of SPSS, one for EFA and the other for CFA. Because of the one-to-one correspondence between the use and effectiveness of CABS, this study, like Dr. P. Castagna's study, analyzed the use and effectiveness scales in parallel.²⁴

If the Kaiser-Meyer-Olkin (KMO) test result was greater than 0.60 and Bartlett's sphericity test result was smaller than 0.05, the data was suitable for EFA.^{38–40} EFA was run using principal components analysis (PCA), parallel analysis (PA), and oblique Promax rotation.⁴¹ Items were selected based on a factor loading of 0.40 or higher.⁴²

By constructing Structural Equation Model, CFA was performed to validate the factor structure of the CABS using maximum likelihood estimation. We calculated a sort of indices to evaluate model fit for the models, including Chi-square (χ^2) and degrees of freedom (df), the root mean square error of approximation (RMSEA), the standardized root mean squared residual (SRMR), the comparative fit index (CFI), and the Tucker–Lewis index (TLI). Commonly applied guidelines for adequate model fit suggested: $\chi^2/df < 3$; RMSEA, SRMR < 0.08 ; and CFI, TLI > 0.90 .^{43–45} Moreover, modification indices (MI) were examined to determine opportunities to improve model fit if it was not ideal.⁴³

Criterion Validity

Spearman correlation analysis was employed for variables with skewed distributions to evaluate criterion validity. Covariates controlled during the correlation analysis included group (ADHD group and HC group), gender, age, years of education, comorbidity, medication status, and ADHD subtype. The results underwent Bonferroni multiple comparisons correction with a significance threshold set at $p_{adj} = 0.05$ to control for the potential issue of multiple comparisons, ensuring a more stringent criterion for statistical significance. Analysis of variance (ANOVA) was conducted to investigate the discriminative ability of the CABS scale. Gender- and age-matched ADHD and HC groups were selected, and gender, age, and years of education were controlled as covariates.

Internal Consistency Reliability

The internal consistency reliability of the CABS was confirmed by Cronbach alpha coefficient. If Cronbach's α coefficient was equal to or greater than 0.70, it indicated acceptably.⁴⁶

Test-Retest Reliability

Test-retest reliability (2-week interval) was represented using intraclass correlation coefficient (ICC) for a subset of the ADHD group. ICC could be interpreted according to the following guidelines: < 0.50 , poor reliability; $0.50–0.75$, moderate reliability; $0.75–0.90$, substantial reliability; > 0.90 , excellent reliability.⁴⁷

Ecological Characteristic Analysis

ANOVA was employed to compare ADHD subgroups based on gender, ADHD subtype, comorbidities, and medication status, while controlling for demographic variables as covariates.

Results

Sociodemographic Characteristics

The participants in this study were 306 adults, 213 (69.61%) with ADHD, and 93 (30.39%) HC. The mean age was 26.43 years ($SD = 5.32$), with 46.08% males. The average number of years of education was 16.83 years ($SD = 2.61$). The results were shown in [Table 1](#).

In ADHD group, the mean age was 27.06 years ($SD = 6.01$), with 47.42% males. The average number of years of education was 16.30 years ($SD = 2.60$). 117 (54.93%) participants were diagnosed with the inattentive type of ADHD (ADHD-I), and the rest were diagnosed with the combined type (ADHD-C). 56.34% of patients never had pharmacotherapy. 140 (65.73%) participants shared at least one other mental illness, with major depressive disorder (43.19%) being the most common. The detailed results were illustrated in [Table 2](#).

Table 1 The Sociodemographic Characteristics of the Sample Population (n = 306)

	Frequency (%)
ADHD	213 (69.61)
HC	93 (30.39)
Gender (Male)	141 (46.08)
Mean age	Mean (Standard Deviation)
	26.43 (5.32)
Education (years)	16.83 (2.61)

Abbreviations: ADHD, attention-deficit/hyperactivity disorder; HC, healthy controls.

Table 2 The Sociodemographic Characteristics of the ADHD Group (n = 213)

	Frequency (%)
Gender (Male)	101 (47.42)
ADHD type	
ADHD-I	117 (54.93)
ADHD-C	96 (45.07)
Comorbidity	
Without comorbidity	73 (34.27)
With comorbidity	140 (65.73)
Major depressive disorder	92 (43.19)
Bipolar disorder	28 (13.15)
Dysthymia	8 (3.76)
Anxiety disorders	
Generalized anxiety disorder	15 (7.04)
Social anxiety disorder	24 (11.27)
Specific phobia	12 (5.63)
Panic disorder	11 (5.16)
Agoraphobia	2 (0.94)
Unspecified anxiety disorder	6 (2.82)
Obsessive-compulsive disorder	20 (9.39)
Eating disorder	11 (5.16)
Alcohol-related disorders	7 (3.29)
Using medication	
Yes	93 (43.66)
No	120 (56.34)
Mean age	Mean (Standard Deviation)
	27.06 (6.01)
Education (years)	16.30 (2.60)

Abbreviations: ADHD, attention-deficit/hyperactivity disorder; ADHD-I, inattentive type of ADHD; ADHD-C, combined type of ADHD.

Content Validity

For all items, the I-CVI ranged from 0.83 to 1.00. The S-CVI/Ave was 0.98. The above two indicators indicated that CABS had good content validity.

Construct Validity

EFA

For the use subscale of CABS, the Bartlett test of sphericity was significant ($\chi^2(91) = 1006.557; p < 0.001$), and the KMO index was 0.83, indicating the suitability of the data for EFA. The first three eigenvalues in the use subscale of the CABS

were 5.32, 2.06, and 1.26. The first three eigenvalues in the parallel analysis were 1.55, 1.41 and 1.31, suggesting we could extract two factors for the use of CABS. Item 9 was deleted due to low loading since loading was -0.02 and 0.16 , respectively. After Item 9 was eliminated, the Bartlett test of sphericity was still significant ($\chi^2(78) = 969.342; p < 0.001$), and the KMO index was 0.84 . In combination with the naming method of Castagna's study, factor 1 was defined as present-oriented, and factor 2 as future-oriented. Factor loadings of the EFA with the use of CABS were described in Table 3.

For the effectiveness subscale of CABS, the Bartlett test of sphericity was significant ($\chi^2(91) = 1129.558; p < 0.001$), and the KMO index was 0.85 , indicating the suitability of the data for EFA. The first three eigenvalues in the effectiveness subscale of the CABS were 5.97 , 1.68 , and 1.14 . The first three eigenvalues in the parallel analysis were 1.55 , 1.41 , and 1.31 , suggesting we could extract two factors for the effectiveness of CABS. Item 9b was deleted due to low loading since loading was 0.19 and 0.24 , respectively. After Item 9b was eliminated, the Bartlett test of sphericity was still significant ($\chi^2(78) = 1090.328; p < 0.001$), and the KMO index was 0.85 . This subscale's factor structure directly paralleled the CABS use section. Factor 1 was defined as future-oriented, and factor 2 as present-oriented. Factor loadings of the EFA with the effectiveness of CABS were shown in Table 4.

CFA

For the use and effectiveness subscale of CABS, CFA was performed for 13 items under the two factors identified by preliminary EFA, separately (Figure 1). Table 5 displayed the CFA model fit indices in each subscale before and after modification.

Criterion Validity

The correlation results among CABS and criterion tools were presented in Table 6. The findings revealed significant correlations between CABS and ADHD-RS inattention subscale ($r = -0.24$ to $-0.11, p_{adj} < 0.001$), as well as BRIEF-A PO ($r = -0.36$ to $-0.18, p_{adj} < 0.001$), BRIEF-A OM ($r = -0.50$ to $-0.20, p_{adj} < 0.001$), and Mazes ($r = -0.09$ to $0.08, p_{adj} < 0.05$).

We utilized age- and gender-matched ADHD patients ($n = 90$) and HC ($n = 90$) for disease discriminant analysis, as shown in Table 7. The ADHD group had significantly lower scores in all subscores in CABS than HC group (present-oriented use: $F = 83.200, p < 0.001$; future-oriented use: $F = 7.119, p = 0.008$; present-oriented effectiveness: $F = 59.333, p < 0.001$; future-oriented effectiveness: $F = 11.166, p = 0.001$).

Table 3 Factor Loadings of the EFA with the Use Subscale of CABS ($n = 153$)

Item Number	Factor	
	Factor 1 (Present-Oriented)	Factor 2 (Future-Oriented)
1	0.659	-0.037
2	0.728	0.047
3	0.833	-0.061
4	0.788	-0.029
5	0.039	0.805
6	0.025	0.846
7	-0.117	0.914
8	0.064	0.836
10	0.654	0.100
11	-0.092	0.670
12	0.175	0.536
13	0.556	0.112
14	0.772	-0.076

Abbreviations: EFA, Exploratory factor analysis; CABS, Compensatory ADHD Behaviors Scale.

Table 4 Factor Loadings of the EFA with the Effectiveness Subscale of CABS (n = 153)

Item Number	Factor	
	Factor 1 (Present-Oriented)	Factor 2 (Future-Oriented)
1b	0.490	0.253
2b	0.648	0.090
3b	0.889	-0.193
4b	0.910	-0.159
5b	-0.073	0.850
6b	-0.086	0.892
7b	-0.139	0.917
8b	0.047	0.832
10b	0.509	0.301
11b	0.240	0.533
12b	0.303	0.538
13b	0.544	0.165
14b	0.685	-0.006

Abbreviations: EFA, Exploratory factor analysis; CABS, Compensatory ADHD Behaviors Scale.

Internal Consistency Reliability

The value of Cronbach’s alpha was 0.85 for the present-oriented use subscale of CABS. For the future-oriented use, present-oriented, and future-oriented effectiveness subscale, Cronbach’s alpha was 0.86, 0.85, and 0.87 successively.

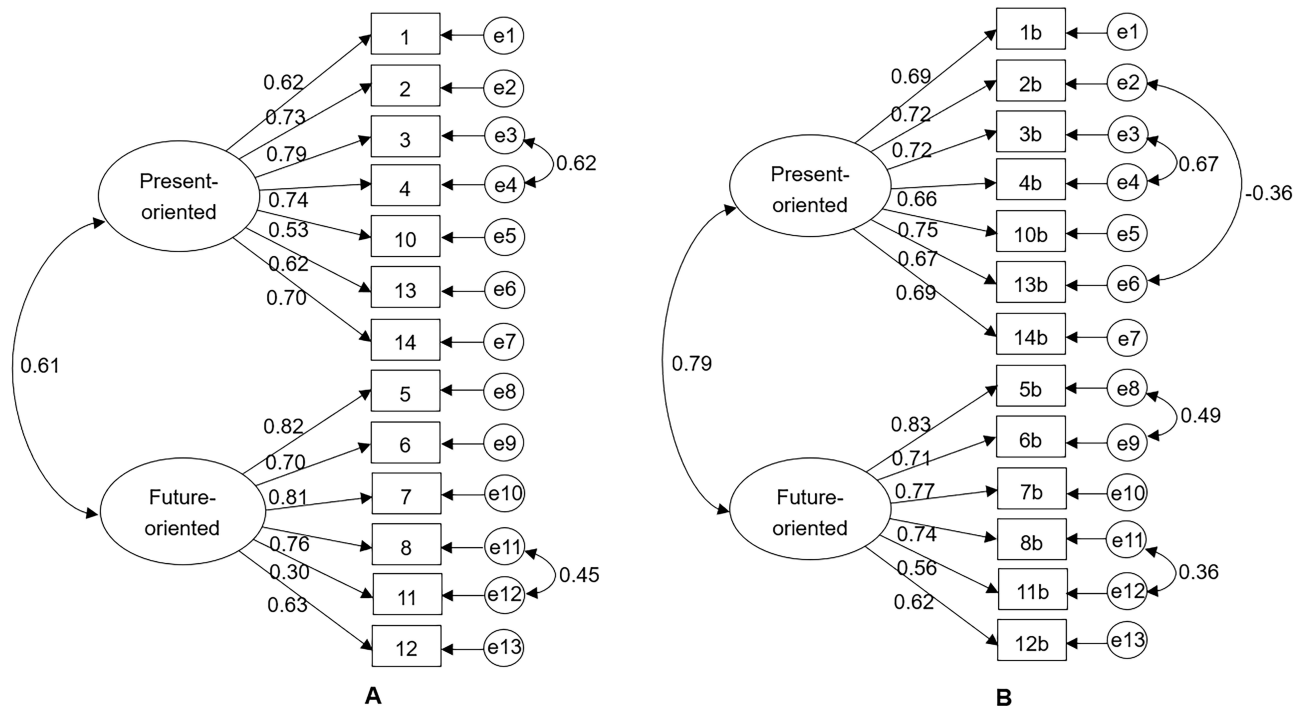


Figure 1 (A) The structural equation model of the use subscale of CABS; (B) The structural equation model of the effectiveness subscale of CABS.

Table 5 Model Fit Indices of the CFA Before and After Modification (n=153)

Models	χ^2/df	RMSEA	SRMR	CFI	TLI
Use subscale					
Before modification	2.850	0.110	0.082	0.874	0.846
After modification	1.925	0.078	0.072	0.939	0.923
Effectiveness subscale					
Before modification	4.040	0.141	0.082	0.825	0.787
After modification	2.229	0.090	0.061	0.934	0.914

Abbreviations: CFA, Confirmatory factor analysis; χ^2/df , Chi-square/Degrees of freedom; RMSEA, Root mean square error of approximation; SRMR, Standardized root mean squared residual; CFI, Comparative fit index; TLI, Tucker–Lewis index.

Table 6 Results of Criterion Validity (n = 306)

	Present-Oriented Use	Future-Oriented Use	Present-Oriented Effectiveness	Future-Oriented Effectiveness
ADHD-RS inattention score	-0.24***	-0.18***	-0.11***	-0.13***
ADHD-RS hyperactivity/ impulse score	-0.00	-0.05	-0.01	-0.02
ADHD-RS total score	-0.17***	-0.11***	-0.08*	-0.09***
BRIEF-A PO	-0.36***	-0.21***	-0.19***	-0.18***
BRIEF-A OM	-0.50***	-0.28***	-0.30***	-0.20***
Mazes	-0.00	0.08**	-0.09**	-0.07*

Notes: * $p_{adj} < 0.05$; ** $p_{adj} < 0.01$; *** $p_{adj} < 0.001$; Controlling for group, gender, age, years of education, comorbidity, medication status, and ADHD subtype during the analysis.

Abbreviations: ADHD-RS, ADHD Rating Scale; BRIEF-A, Behavior Rating Inventory of Executive Function-Adult Version; PO, Plan/Organize; OM, Organization of Materials; Mazes, Neuropsychological Assessment Battery: Maze.

Table 7 Results of Discriminative Ability

	ADHD Group (n = 90)	HC Group (n = 90)	χ^2/t value	p value
Male [n (%)]	40 (44.44)	39 (43.33)	0.023	0.881
Mean age (years)	25.11 (1.80)	24.73 (2.42)	1.118	0.237
Education (years)	16.88 (2.30)	17.99 (2.18)	-3.325	0.001**
CABS				
Present-oriented use	11.57 (5.99)	19.50 (4.37)	83.200 [^]	< 0.001***
Future-oriented use	10.57 (6.02)	13.20 (4.65)	7.119 [^]	0.008**
Present-oriented effectiveness	13.23 (6.56)	20.67 (4.83)	59.333 [^]	< 0.001***
Future-oriented effectiveness	12.04 (6.51)	15.82 (5.28)	11.166 [^]	0.001**

Notes: [^]F value; ** $p < 0.01$; *** $p < 0.001$; Controlling for gender, age, and years of education during the analysis.

Abbreviations: ADHD, attention-deficit/hyperactivity disorder; HC, healthy controls; CABS, Compensatory ADHD Behaviors Scale.

Test-Retest Reliability

The test-retest analysis was performed for a group of 40 ADHD subjects (2-week interval). The value of ICC was 0.79 ($p < 0.001$), 0.88 ($p < 0.001$), 0.67 ($p < 0.001$), and 0.59 ($p < 0.001$) for the present-oriented use, future-oriented use, present-oriented effectiveness, and future-oriented effectiveness subscale of CABS.

Ecological Characteristic of ADHD

In the ADHD group, there were no differences in CABS scores among subgroups based on gender, ADHD subtype, and comorbidities. However, in the medication status subgroups, it was found that the medicated group had significantly higher scores in the future-oriented effectiveness subscale compared to the non-medicated group ($F = 6.106$, $p = 0.014$). See [Tables S1–S4](#) for detailed results.

Discussion

This study introduced the CABS for the first time in China. The results revealed that the CABS demonstrated good reliability and validity. Using this scale, it was observed that compensatory behaviors in adults with ADHD were significantly lower compared to the healthy population. Unfortunately, previous studies have not explored the relationship between compensatory behaviors in ADHD patients and healthy individuals. However, in the study by Castagna et al, they found that individuals who did not self-report ADHD diagnosis had higher CABS scores compared to those who self-reported ADHD diagnosis, except for the future-oriented use subscale.²⁴ Although this study provided some insights, the characteristics of the participants differed from those in our study, so the results could only be considered as a reference. Therefore, further research is needed to validate the relationship between ADHD and compensatory behaviors in healthy individuals.

To the best of our knowledge, CABS had not been introduced to other countries. This study, which investigated the reliability and validity of the Chinese version of CABS, was the first attempt to translate CABS into another language. This also suggested that future research might be needed to further explore the applicability and stability of CABS in different cultural contexts.

This study not only included individuals diagnosed with ADHD but also incorporated healthy adults, based on the following considerations: (1) The content measured by the CABS covered the organizational and management skills of tasks or activities in daily life, which were common among healthy people and widely applied by the general public. Therefore, the content evaluated by the CABS was widely applicable, though there may be quantitative differences among different groups. From the perspective of measurement content, the scale was suitable not only for ADHD patients but also for testing in healthy participants. (2) The reliability of the scale aimed to measure the stability of the results obtained by the scale, and the validity of the scale aimed to measure the extent to which the scale accurately assessed a specific trait.⁴⁸ In other words, the focus of reliability and validity studies was mainly on the internal structure of the scale and the consistency of measurement results at different times, and the inclusion of different groups had minimal impact on the aforementioned analyses.

Content Validity

Based on the results evaluated by six experts in the expert committee, the content validity was considerable both at the scale level and item level. Regrettably, Castagna et al did not investigate the content validity of the CABS.²⁴ Therefore, this study was the first to explore the content validity of CABS. However, in light of this, additional research is warranted to further validate the content validity in the future.

Construct Validity

In both EFA and CFA, this study separately investigated the usefulness and effectiveness subscales of the CABS. This approach was motivated by the item design of the CABS, where each item in the use and effectiveness subscale exhibited complete consistency and correspondence. Given the one-to-one correspondence between the use and effectiveness of CABS, our study, similar to Dr. P. Castagna's original research,²⁴ analyzed these scales in parallel, treating them as distinct measures assessing different aspects of the same behavior (utilization and helpfulness). This paper aimed to explore the underlying factors of compensatory behaviors, and conducting EFA/CFA on both measures would not provide insights into this question; hence, we deemed shared variance inappropriate. To validate our assumption, we combined the two subscales for EFA, employing the same analysis method as in this study. The results, presented in [Table S5](#), indicated high multicollinearity among corresponding items of the two subscales, and the combined results were less than ideal. Consequently, we refrained from further analyzing the CFA data under this outcome. The approach taken in studying the Liebowitz Social Anxiety Scale (LSAS) and the Family Environment Scale (FES) was similar.^{49–51}

Regarding EFA results, we deleted item 9, “I ask my friends or family to remind me of important tasks or activities that I have”, from the use subscale of the CABS. The items “I ask my friends or family to remind me of important tasks or activities that I have, which helps me” was deleted from the effectiveness subscale. Asking people around to remind you to do something was deleted in terms of use and effectiveness subscale, which may be related to cultural differences in help-seeking behaviors.²⁷ In general, our study’s EFA revealed a two-factor model (future-oriented and present-oriented), consistent with the original study.²⁴

In addition to validating the scale by EFA, we also conducted CFA using random samples from the collected data. Based on our EFA results, the results of CFA showed good fitness for the factor structural model of the CABS, which confirmed its construct validity. However, it should be noted that this study used MI to improve the model fit. For the modified items, the fitted paths were reasonable in terms of content, but the model derived only according to the characteristics of the data set in this study may have certain limitations in generalizing to broader populations. Further research is needed in the future to validate these findings across diverse populations.

Criterion Validity

Subsequently, in the criterion validity of CABS, we found a significant negative association between ADHD compensatory behavior and inattention symptoms, rather than hyperactivity/impulsivity symptoms. The original study also acknowledged the association between compensatory behaviors and ADHD symptoms. Unfortunately, the original research did not further differentiate ADHD symptoms into inattention and hyperactivity/impulsivity symptoms.²⁴ This may mean that people with ADHD could better compensate for attention deficits if they successfully use organization strategies, which was consistent with one hypothesis that may lead to a delayed diagnosis of ADHD.^{12,52}

In addition, the more compensatory behaviors were observed, the stronger the scale-based organizational and planning abilities, consistent with the findings of the original study.²⁴ This study also employed operational tests for EF assessment, but the results revealed relatively small correlation coefficients. Therefore, caution is warranted in interpreting these findings. However, differences between scale-based and performance-based EF assessment tools have been reported in previous studies, confirming that the scale- and performance-based tools may evaluate EF based on separate but associated mental structures.^{53,54} Specifically, performance-based measures indicated the algorithmic mind, and rating measures indicated the reflective mind, supplying different types of information for clinical assessment.⁵⁵ As shown in self-administered questionnaires, attention-executive deficits may not be as severe in neuropsychological tests.^{56,57}

Nearly half (43.7%) of the ADHD subjects in our study were on pharmacotherapy. As it has been widely recognized, ADHD medication could significantly improve the core symptoms and executive dysfunction.^{58–60} However, the relationship between compensatory behavior and medication was still inconclusive. Despite controlling for medication status as a covariate in the criterion validity correlation analysis, the results may still have been influenced to some extent. On the one hand, studies have also found that stimulants significantly improve patients’ organization, time management, and planning. These improvements were associated with a significant reduction in ADHD symptoms.⁶¹ On the other hand, previous studies have suggested that medication may help reduce effort-related compensatory strategies since ADHD participants believed they wasted less time and did not need to invest extra effort to get things done.¹⁸ The above inconsistent conclusions may affect the results of CABS criterion validity. Therefore, the ADHD group was divided into medication and non-medication subgroups, and the criterion validity of CABS in the two subgroups was analyzed specifically (see [Tables S6](#) and [S7](#) for the results). The results showed that although the correlations of the CABS and other indicators were less evident than the total sample ($n = 306$), compensatory behavior was still significantly negatively correlated with ADHD symptoms and executive dysfunction. This correlation trend was consistent with the total sample results, which means our study’s criterion validity outcomes should be credible.

In addition, the compensatory behaviors of different groups in our sample were compared to verify the disease differentiation of CABS. The results indicated that CABS could significantly distinguish HC from ADHD populations ($p < 0.001$). That was, the compensatory behavior of adults with ADHD was considerably less than that of healthy population. However, above conclusion was only preliminary conjectures based on the study with a small sample, which needed to be confirmed in future investigations.

Reliability

We explored the reliability of the CABS from internal consistency (Cronbach's alpha: 0.85–0.87), which showed CABS exhibited acceptable internal consistency reliability. In terms of test-retest reliability, the use subscale of CABS demonstrated a substantial level of reliability (ICC: 0.79–0.88), while the effectiveness subscale showed a moderate level of reliability (ICC: 0.59–0.67). This result indicated that the test-retest reliability of the CABS scale was moderate to substantial, but also suggested that the test-retest reliability of the effectiveness subscale was lower compared to the use subscale. The discrepancy in test-retest reliability may be attributed to the characteristics of the sample used for retesting. Further research is needed to validate the findings of this study.

Ecological Characteristic of ADHD

The analysis of ADHD subgroups revealed that gender, ADHD subtype, and comorbidities had no significant impact on compensatory behaviors in adults with ADHD. Given the limited research on the compensatory behaviors in adults with ADHD, further validation of these results is needed in the future studies. A single qualitative study found no significant gender differences in the use of compensatory behaviors, supporting our findings.¹³ In this study, only ADHD-I and ADHD-C patients were recruited, and no significant differences in compensatory behavior were found between the two subgroups. This result may indirectly suggest a less pronounced association between compensatory behaviors and hyperactive/impulsive symptoms. However, it is crucial to note that this is a speculative interpretation. To further clarify our hypothesis, future research could include participants diagnosed with hyperactive/impulsive type of ADHD (ADHD-HI) for further investigation.

The results of comorbidities in subgroups could be understood from the following perspective: there is considerable neurocognitive heterogeneity in mental disorders,⁶² and the CABS scale only covers compensatory behaviors related to organization and planning. Therefore, the CABS may not be able to assess compensation underlying all mental disorders. Additionally, this study did not thoroughly assess the characteristics of comorbidities (duration of disease, use of comorbidity-related drugs, overall functional impairment, etc.), which could potentially impact the accuracy of the results.

The only influential factor was medication, demonstrating a positive effect on compensatory behaviors. Specifically, medication did not increase the use of compensatory behaviors, but enhanced the effectiveness of compensatory behaviors. The conclusion came as a surprise to us, and it was contrary to previous findings that suggested medication might help reduce compensatory behaviors in individuals with ADHD.^{18,20} This study emphasized that medication played a positive role in the effectiveness of implementing compensatory behaviors in ADHD patients, rather than focusing on the quantity of behaviors, providing a new perspective on the mechanisms of pharmacotherapy. However, it should be noted that this study served as an initial exploration; subsequent research with more rigorous design is needed to confirm the findings of this study.

Strengths and Limitations

The study has several strengths. First, it was the first time introducing the measurement tool of compensatory behavior in China. We verified its reliability and validity in the Chinese population, providing a scientific instrument for future research on compensatory behavior in China. Second, we conducted both EFA and CFA, which made a relatively complete exploration of the construct validity of CABS. Third, we explored for the first time the ecological characteristics of compensatory behavior in adults with ADHD.

There are several limitations to the current study. Firstly, the age of the sample population tended to be younger ($M_{age} = 26.43$ years, $SD = 5.32$) than the original study ($M_{age} = 36.83$ years, $SD = 11.57$).²⁴ Future studies should consider including participants from a wider age range to improve the representativeness of the sample. Secondly, ADHD patients in this study were only recruited from Peking University Sixth Hospital. Although outpatients may come from various regions across the country, detailed information on the participant's places of residence was not collected. Therefore, there may be a certain degree of selection bias in the recruitment of subjects in this study. Similarly, the recruitment of HC also faced the same issue, with the recruitment centering in Beijing. In the future, on one hand, consideration could be given to conducting multicenter studies to comprehensively include ADHD and HC populations from different regions, thereby improving the representativeness of samples and the credibility and generalizability of the research

results. On the other hand, attention should be paid to collecting more detailed demographic characteristics of participants, such as long-term residence, to facilitate subsequent more detailed statistical analysis. Thirdly, the study did not include individuals with ADHD-HI. A previous review indicated that ADHD-I was the most common type of adult ADHD, followed by ADHD-HI and ADHD-C,⁶³ which may reflect the possible selection bias in the recruitment of subjects for this study, and also limit the generalization of the conclusions of this study. Therefore, it is necessary to ensure that the samples cover a wider range of clinical characteristics in future studies to improve the representativeness of the samples. Fourthly, although we used indicators such as ADHD symptoms and executive dysfunction (Plan/Organize and Organization of Materials) as the scale's criterion validity, it is better to use the gold standard with the same structure as CABS to test the criterion validity.⁶⁴ Unfortunately, no such tools are available in China for the time being. Last but not least, in the criterion validity, except for one neuropsychological test of EF, other evaluation indicators were self-rating scales, which lacked objective evaluation tools. Future studies may consider including the other-rating tool to provide a more objective and comprehensive assessment of study. Such methodological improvements can not only enhance the reliability of the results, but also provide more detailed insights into the findings.

Conclusion

The Chinese version of CABS proved good validity and reliability in this study and demonstrated to be a valid tool for assessing compensatory behaviors in Chinese adults. With the CABS, we can better measure the compensatory ability of adult ADHD in an easy and time-efficient manner and have more opportunity to explore the relationships between compensatory behaviors and ADHD symptoms, as well as daily functioning of ADHD. At the same time, it also provides us with the possibility to explore the potential mechanism of ADHD compensatory behavior. Furthermore, we also found that medication positively influenced the effectiveness of compensatory behaviors. This suggests a potential relationship between medication treatment and compensatory behaviors, which needs further exploration in future research.

Data Sharing Statement

The data in this study are available from the corresponding authors upon reasonable request.

Ethics Approval and Informed Consent

The study was conducted in accordance with the Declaration of Helsinki, and approved by the Ethics Committee of the Peking University Sixth Hospital (protocol code: 2022-39).

Consent for Publication

All authors have approved the details of the manuscript to be published, and all authors providing consent have reviewed the article contents to be published.

Informed Consent Statement

Informed consent was obtained from all subjects involved in the study.

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Author Contributions

All authors made a significant contribution to the work reported, whether that is in the conception, study design, execution, acquisition of data, analysis and interpretation, or in all these areas; took part in drafting, revising or critically reviewing the article; gave final approval of the version to be published; have agreed on the journal to which the article has been submitted; and agree to be accountable for all aspects of the work.

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Disclosure

The authors report no conflicts of interest in this work.

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