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Psychometric properties of the Dimensional Anhedonia Rating Scale in Chinese typical, subthreshold, and clinically depressed adolescents

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Abstract

The Dimensional Anhedonia Rating Scale measures state anhedonia in multiple domains, such as hobbies, food and drink, social activities, and sensory experience, and it has good reliability and validity in adult samples. However, no study has examined the psychometrical properties of this scale in adolescents. The present study examined its reliability and validity in adolescents with and without depression. In Study 1, 988 high-school students completed the Dimensional Anhedonia Rating Scale; 915 completed the second-round survey 3 months later. Confirmatory factor analysis was used to determine the factor structure. Additionally, internal consistency and test–retest reliability, and concurrent, convergent, and divergent validity were assessed in typical adolescents. In Study 2, the Dimensional Anhedonia Rating Scale was administrated to 108 patients with major depressive disorder, 108 adolescents with subthreshold depression, and 108 healthy controls. Factor structure and convergent validity were assessed in the clinical and subclinical groups. Finally, a one-way analysis of variance (ANOVA) was applied to examine the effect of depression severity on the scale scores. The results of Study 1 indicated that a four-factor model (i.e., hobbies, food and drink, social activities, and sensory experience) best fit the data. Meanwhile, the scale also yielded good concurrent, convergent, and divergent validity, as well as high internal consistency and test–retest reliability, in typical adolescents. In Study 2, goodness-of-fit statistics also suggested a good fit for the four-factor model in the two depressed groups. The one-way ANOVA revealed significant group differences in the total and factor scores, whereby the major depressive disorder group had lower scores than the subthreshold depression group, whose scores were lower than the healthy controls, indicating excellent eligibility of the scale in depressed adolescents. The Chinese version of the Dimensional Anhedonia Rating Scale is a reliable and valid instrument to comprehensively measure state anhedonia in Chinese typical and depressed adolescents.

KEYWORDS
anhedonia, Chinese adolescents, depression, reliability, validity

INTRODUCTION

Anhedonia, defined as reduced experience of pleasure (Ho & Sommers, 2013), has been recognized as a core feature of major depressive disorder (MDD; American Psychiatric Association [APA], 2013). Anhedonia predicts poor psychosocial functioning (Vinckier et al., 2017) and treatment outcome in patients with depression (McMakin et al., 2012). While much research has focused on the reduction of *in the moment* or consummatory pleasure, emerging studies have suggested that anhedonia is not limited to a unitary conceptualized structure. In fact, the concept of anhedonia has been linked to multiple facets of hedonic processing, such as desire/interest (wanting a reward), anticipation (the readiness state or enjoyment of

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expecting a reward), effort (effort computation and actual effort to attain reward), and consummatory pleasure (enjoyment of the attained reward; Kring & Barch, 2014; Rizvi et al., 2016; Zald & Treadway, 2017). Hence, it is imperative and significant to distinguish different components of anhedonia mentioned above, which can facilitate a better understanding of psychopathological mechanisms in MDD and shed light on future preventions and treatments for heterogeneous symptoms of MDD.

Moreover, anhedonia can be treated either as a transitory state fluctuating with different clinical periods (Blanchard et al., 2001; McFarland & Klein, 2009), or a trait related to a stable individual tendency over time (Harvey et al., 2007; Pechtel et al., 2013). Accordingly, scales that measure trait and state anhedonia have been developed and validated over the years. Trait scales measure long-term anhedonia (*in general*) while state scales assess anhedonia during a recent short time period (*the last few days* or *right now*). Two of the most widely used scales to measure state anhedonia in people with depression are the Fawcett–Clark Pleasure Scale (Fawcett et al., 1983) and the Snaith–Hamilton Pleasure Scale (SHAPS; Snaith et al., 1995). However, these two scales only focus on the consummatory pleasure component *at this moment* (Fawcett–Clark Pleasure Scale) or *in the last few days* (SHAPS) in various rewarding contexts (e.g., Fawcett–Clark Pleasure Scale: sensory experiences, social activities, and sense of dominance of difficult tasks; SHAPS: hobbies, food and drink, social activities, and sensory experience). They did not tap into other components of anhedonia. As for the trait scales, the Temporal Experience of Pleasure Scale (TEPS; Gard et al., 2006) and the Anticipatory and Consummatory Interpersonal Pleasure Scale (Gooding et al., 2014) have recently been developed to capture trait anhedonia in terms of both anticipatory and consummatory experiences of pleasure.

Considering that adolescence is a critical period both for the development of depressive symptoms and for changes in hedonic and reward-related processing (Forbes & Dahl, 2012), state anhedonia may be more appropriate to capture the change of anhedonia experiences in adolescents, as well as to enhance our understanding of developmental psychopathological mechanisms of depression in adolescents (Kouros et al., 2016; Watson et al., 2021). In contrast to the TEPS and the Anticipatory and Consummatory Interpersonal Pleasure Scale, which measure trait anhedonia, Rizvi and her colleagues developed a novel 17-item scale, called the Dimensional Anhedonia Rating Scale (DARS), to measure state anhedonia, covering different aspects of reward-related processing, including desire, motivation, effort, and consummatory pleasure (Rizvi et al., 2015). By asking participants to recall or imagine favorite scenes related to each domain instead of presenting fixed scenarios, the DARS can avoid cultural-, sex-, and age-related biases. The DARS has been found to have good reliability and validity in Canadian, Spanish, German, and Chinese adult samples (Arrua-Duarte et al., 2019; Jia et al., 2020; Rizvi et al., 2015; Wellan et al., 2021). Rizvi and colleagues validated the DARS in a community and depressed sample, which revealed a four-factor model including hobbies, food/drink, social activities, and sensory experience (Rizvi et al., 2015). The Spanish version of the DARS has been found to have a strong internal consistency and adequate validity among diverse clinical samples (i.e., individuals with depressive disorders, psychotic disorders, adjustment disorders, and anxiety disorders; Arrua-Duarte et al., 2019). Similarly, the validation of the Chinese version of the DARS in a sample of patients with clinical depression confirmed the same four-factor model as the original version of the DARS, and was reported to have high reliability and adequate validity (Jia et al., 2020).

However, the existing versions of the DARS have been only validated for the use in adults, and little is known about the psychometric properties of the DARS in an adolescent sample. Moreover, due to the strong impact of sex and stress hormones on dopamine neurotransmission in the adolescent brain (Spear, 2000), extraordinarily heightened neural responsivity to rewarding stimuli in the ventral striatum, insula, and orbitofrontal cortex has been consistently observed in typical adolescents, accompanied by more intense hedonic experiences (Galvan, 2010; Galván, 2014; Galvan et al., 2006; Hansen et al., 2019; Lorenz et al., 2014; Qu et al., 2015; Silverman et al., 2015; Somerville et al., 2010; Steinberg, 2008; Van Leijenhorst et al., 2010). Additionally, the period of adolescence has been associated with a higher risk for increases in depressive symptom severity (Thapar et al., 2012), along with substantial impairments in the hedonic capacity (Burani et al., 2019; Kujawa et al., 2020; O'Callaghan & Stringaris, 2019; Rappaport et al., 2020). Taken together, this evidence highlights the importance of validating the DARS in adolescents, which will in turn allow researchers to effectively measure hedonic manifestation in typical and depressed adolescents (Forbes & Dahl, 2012; Luking et al., 2016).

The purpose of the current study was to evaluate the psychometric properties of the Chinese version of the DARS in typical and depressed adolescents. To this aim, we performed two independent studies. The aim of Study 1 was to assess the factor structure, internal and test–retest reliability, and concurrent, convergent, and divergent validity for the DARS in a community sample of healthy adolescents. The aim of Study 2 was to further examine the factor structure of the DARS in adolescents with subthreshold depression (SD) and clinical depression. Given that the four-factor model of the DARS has been consistently reported in Canadian, Spanish, and Chinese samples, we expected that the same four-factor model would fit the data in typical and depressed adolescents. Second, we hypothesized that the DARS would have an acceptable test–retest reliability and internal reliability. Finally, we hypothesized that the DARS would have good concurrent and convergent validity, as indicated by strong relationships between scores on the Children's Depression Inventory (CDI) and scores of scales measuring anhedonia level or hedonic capacity. We also expected individuals with clinical and subthreshold depression to have lower DARS scores (i.e., higher levels of anhedonia) than healthy participants.

STUDY 1

Methods

Participants

In Study 1, all participants were enrolled from a senior high school in China. We randomly selected the school from a community where all the students were invited to participate in the survey and around one-third of them agreed to participate. Eventually, 1,000 students completed the initial survey and the second-wave survey 3 months later. Twelve subjects, who were older than 18 years old and/or self-reported personal psychiatric disorders or a family history of mental illness, were excluded. Seventy-three participants who completed the initial survey dropped out during the second-wave survey. As the result, data from a total of 988 participants for the initial survey and 915 for the second wave were finally included in the statistical analysis. All subjects gave their written informed consent to participate during the initial survey. This study was approved by the Ethical Committee on Human Research of East China Normal University.

Measures and procedures

We employed the Chinese version of the DARS to measure state anhedonia in adolescents (Jia et al., 2020). The 17-item DARS has four subscales, including Hobbies, Food/Drink, Social Activities, and Sensory Experience. Each subscale begins with a fill-in-the-blank question that evokes pleasurable emotions, whereby the participant is asked to list at least two things/experiences relevant to the scenario that gives them pleasure. This was followed by 4 or 5 questions (e.g., "I want to have these foods/drinks", "I would actively seek out these experiences") that were rated from 0 to 4 on a scale of *not at all*, *slightly*, *moderately*, *mostly*, and *very much*, whereby a lower score indicates a higher level of state anhedonia. Although the original DARS was designed for adults, the wordings in the DARS are easily understandable and the reward scenarios seem universal for people of different ages. Therefore, we supposed that the invariable DARS is appropriate for adolescents and did not make any revision to DARS items. Permission to use the DARS was obtained from Dr Rizvi (original version of the DARS) and Dr Si (Chinese version of the DARS) before the start of the study.

In addition, the Chinese version of the Children's Depression Inventory (CDI) was used; this scale measures the level of depression in Chinese children and adolescents, and has good reliability and validity (Wu et al., 2010). Higher total scores indicate more severe depressive symptoms, with a cut-off score of 19 indicating subthreshold depression. The Chinese version of the SHAPS, which has good reliability and validity in both clinical and non-clinical samples (Liu et al., 2012; Zhang et al., 2021), was employed to measure anhedonia symptoms. Lower total scores indicate higher levels of anhedonia. While the SHAPS has not been explicitly validated in Chinese adolescent samples, a study conducted in high-school freshmen in Western culture contexts showed high construct validity of the SHAPS (Leventhal et al., 2015). The Chinese version of the TEPS was used to measure the degree of trait anhedonia in two distinct dimensions (i.e., anticipatory and consummatory pleasure). Lower scores indicate higher levels of anhedonia. Although the Chinese version of the TEPS was first validated in adult samples (Chan et al., 2012), it has been administered to adolescent samples later and has shown good validity (Gooding et al., 2017). Finally, the Chinese version of the Behavioral Inhibition/Activation System (BIS/BAS) scale, which has a high reliability and validity in a large Chinese sample aged 12–24 years old (Tian et al., 2017), was used to assess behavioral inhibition and behavioral activation components (e.g., reward response, drive, and pleasurable experiences).

Data analysis

Data analysis was conducted using statistical package for social sciences (SPSS) version 22.0 and AMOS 21.0 (IBM, released 2013; IBM SPSS Statistics for Windows, Version 22.0). First, we performed confirmatory factor analysis (CFA) on the DARS items to assess the assumed DARS four-factor structure, with the use of robust maximum likelihood as the method of estimation in AMOS 21.0. Robust model fit indices for the CFA included the following: robust chi-square/degrees of freedom (≤3 indicates a good fit); the goodness-of-fit index (GFI; Miles & Shevlin, 1998), the adjusted goodness-of-fit index (AGFI; Mulaik et al., 1989), the comparative fit index (CFI; Bentler, 1990), the normed fit index (NFI; Bentler & Bonett, 1980), and the Tucker–Lewis index (TLI; Tucker & Lewis, 1973), with values of these indices approaching 1 implying a good model fit (>.90, *acceptable*; >.95, *good*; >.97, *very good*; Brown, 2003); and the root-mean-square error of approximation (RMSEA); Browne & Cudeck, 1992), with its value approaching zero indicating a good model fit (<.08, *acceptable*; <.05, *good*; Brown, 2003).

The internal consistency of the DARS total score and subscale scores was assessed using Cronbach's α and the average inter-item correlation (AIC; Clark & Watson, 1995) in the reliability analysis of SPSS 22.0. Test–retest reliability ($n = 915$) was calculated using the intra-class correlation (ICC) function in SPSS, based on a random effects model.

Concurrent, convergent, and divergent validity were assessed in SPSS using Pearson's correlation analysis between the DARS total and subscale scores and other related indicators. Specifically, concurrent validity of the DARS was determined by calculating correlations between the CDI total score and DARS scores, while convergent validity was assessed by computing associations between DARS scores and the TEPS, SHAPS, and BAS scores. Divergent validity was determined by analyzing the relationship between the DARS and the BIS scores. Furthermore, a correlation coefficient matrix diagram of the DARS and related criterion scales was plotted through the website http://www.bioinformatics.com.cn/plot_basic_corrplot_corrlation_plot_082 for a better

presentation of the relationship between the DARS and related indicators. Finally, to explore the predictive validity of DARS, we conducted a stepwise multiple regression analysis with the second-wave CDI scores as the dependent variable and the demographic factors (such as age, sex ratio) as the baseline predictor variables. In the second step, we added total and four-factor scores of the DARS as predictors to examine whether the DARS scores could be predictive of future depressive symptoms.

Results

Descriptive statistics and demographics

A total of 988 participants (age: $M = 16.58$ years, $SD = 0.78$; sex female : male = 597:391) completed the initial survey, and 915 participants finished the second-round survey (attrition rate: 7.4%).

Confirmatory factor analysis

According to Arrua-Duarte et al.'s (2019) suggestions, we used a four-factor structure model, in which all components were correlated with each other, to test our data. CFA standardized loadings and between-factor correlations for the four-factor DARS model are presented in Figure 1.

The robust fit indices indicated an acceptable to good fit for the four-factor model (GFI = .944, AGFI = .924, RMSEA = .056 (90% confidence interval [CI] = .050 to .061), CFI = .965, NFI = .954, TLI = .958, χ^2/df = 4.052), thereby affirming the differentiation of four hedonic domains (hobbies, food/drink, social activities, and sensory experience). As expected, all items loaded above .60 on each of their respective factors, which indicated a satisfactory four-factor model.

Reliability analysis

The results of the correlation analysis between factor scores and the total DARS score are shown in Figure 2, with the correlation coefficients ranging from .303 to .815 ($ps < .01$). As shown in Table 1, the total DARS scale showed good (Cronbach's α = .902) and acceptable (AIC = .352) internal consistency. Similarly, all DARS subscales had excellent (Cronbach's α = .788 to .907) and moderate to high (AIC matrices ranging from .482 to .671) internal consistency. In addition, the ICC for the total scale and subscales ranged from.616 to.741, which indicates good test–retest reliability over 3 months.

Validity analysis

The result of concurrent validation showed that both total and factor DARS scores were significantly and negatively correlated with the CDI total scores. The convergent validity analysis revealed similar results. Both total scale and subscales of the DARS had significant and negative correlations with the SHAPS and BAS scores ($rs = -.078$ to $-.346$, $ps < .05$). We observed significant and positive correlations between total scale and subscales of the DARS and TEPS total scores ($rs = .300$ to .543, $ps < .01$), and scores of the anticipatory ($rs = .251$ to .495, $ps < .01$) and consummatory TEPS subscales ($rs = .281$ to.471, $ps < .01$). In contrast, the DARS subscale scores only showed weak correlations with the BIS score ($rs = -.09$ to $-.08$, $ps < .05$), and there was no significant correlation between the Social Activity DARS subscale score and the BIS score ($r = -.053$, $p > .05$), which indicates acceptable divergent validity.

Regarding the predictive validity, after controlling the influence of age and sex ratio ($R^2 = .011$, adjusted $R^2 = .009$, $p < .001$), the CDI scores after 3 months was significantly predicted by the total DARS score and its three subscale scores

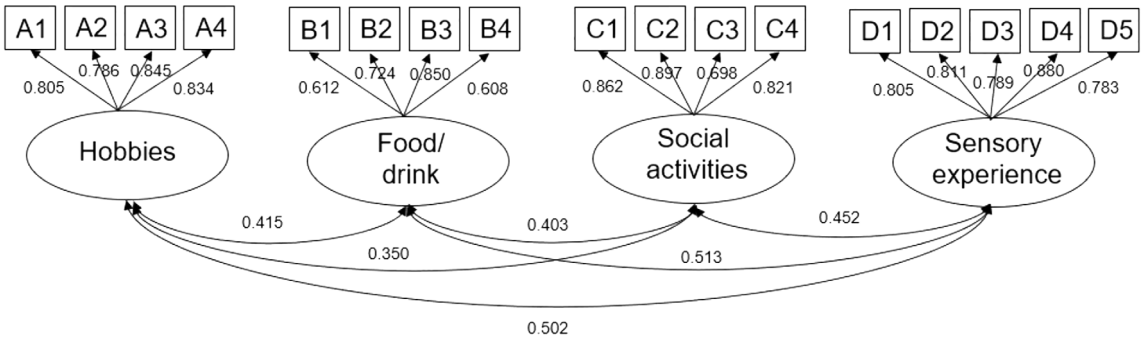

FIGURE 1 Four-factor structure of the DARS. *Note*. A/B/C/D represents the four subscales of Hobbies, Food and Drinks, Social Activities, and Sensory Experiences, respectively. In every subscale of DARS, each item is presented in the form of a domain-related statement. To be specific, A1, "I would enjoy these activities"; A2, "I would spend time doing these activities"; A3, "I want to do these activities"; A4, "These activities would interest me"; B1, "I would make an effort to get/make these foods/drinks"; B2, "I would enjoy these foods/drinks"; B3, "I want to have these foods/drinks"; B4, "I would eat as much of these foods as I could"; C1, "Spending time doing these things would make me happy"; C2, "I would be interested in doing things that involve other people"; C3, "I would be the one to plan these activities"; C4, "I would actively participate in these social activities"; D1, "I would actively seek out these experiences"; D2, "I get excited thinking about these experiences"; D3, "If I were to have these experiences I would savor every moment"; D4, "I want to have these experiences"; D5, "I would make an effort to spend time having these experiences". *Note*. DARS = Chinese version of the Dimensional Anhedonia Rating Scale

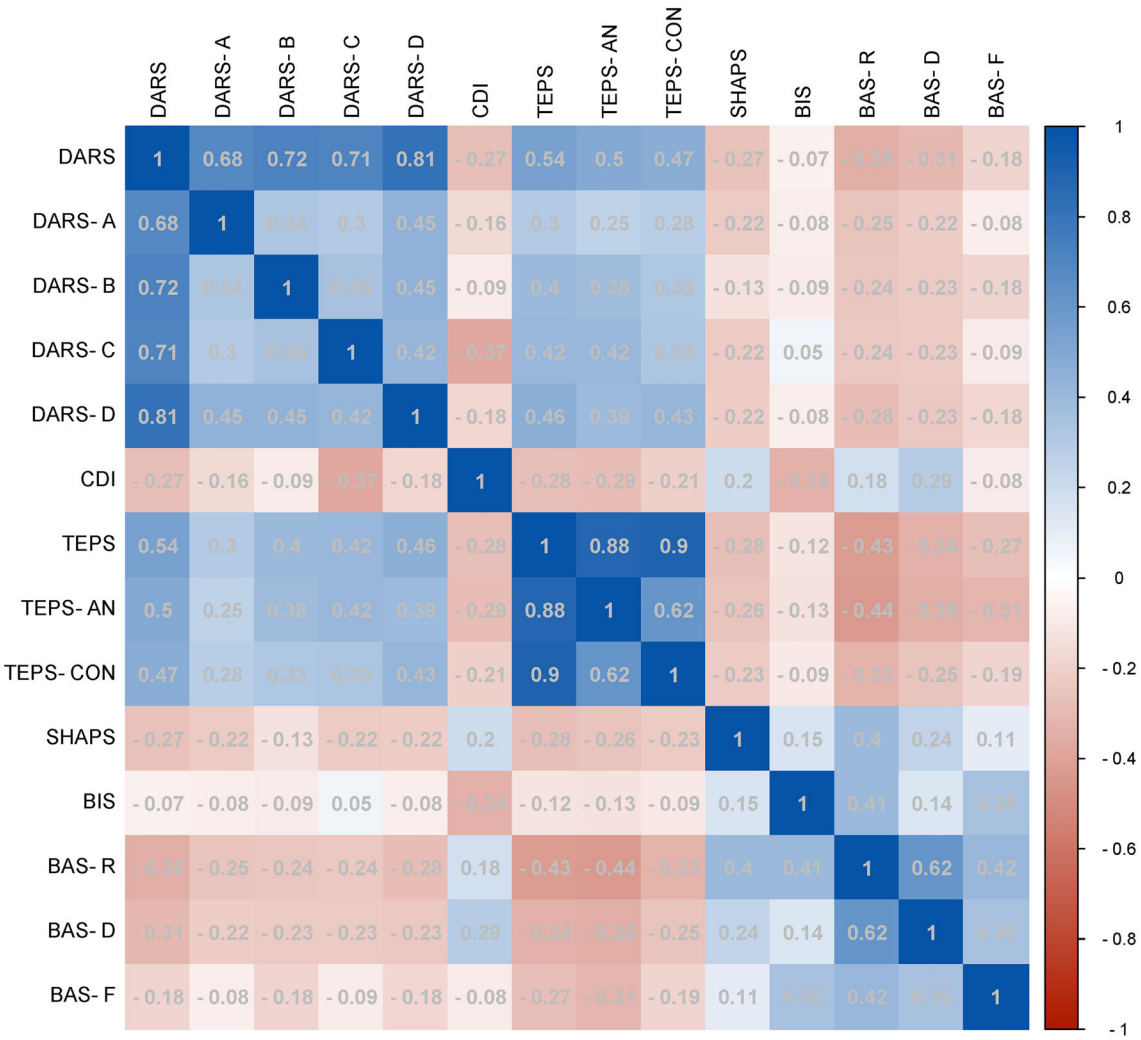

FIGURE 2 Correlation coefficient matrix diagram of the DARS and related criterion scales. *Note*. DARS = Chinese version of the Dimensional Anhedonia Rating Scale; DARS-A = DARS Hobbies Subscale; DARS-B = DARS Food and Drink Subscale; DARS-C = DARS Social Activities Subscale; DARS-D = DARS Sensory Experience Subscale; CDI = Children's Depression Inventory; TEPS = Temporal Experience of Pleasure Scale; TEPS-AN = Temporal Experience of Pleasure Scale-Anticipatory subscales; TEPS-CON = Temporal Experience of Pleasure Scale-Consummatory subscales; SHAPS = Snaith–Hamilton Pleasure Scale; BIS = Behavioral Inhibition System; BAS-R = Behavioral Activation System-Reward responsiveness; BAS-D = Behavioral Activation System-Drive; BAS-F = Behavioral Activation System-Fun seeking

TABLE 1 Internal consistency of the DARS and its subscales

	Cronbach's α	AIC	ICC
Total DARS score	.902	.352	.741**
DARS-A score	.889	.668	.616**
DARS-B score	.788	.482	.638**
DARS-C score	.891	.671	.721**
DARS-D score	.907	.661	.655**

Note. AIC = average inter-item correlation (an acceptable AIC should be moderate, Clark & Watson, 1995); DARS = the Dimensional Anhedonia Rating Scale; DARS-A = DARS Hobbies Subscale; DARS-B = DARS Food and Drink Subscale; DARS-C = DARS Social Activities Subscale; DARS-D = DARS Sensory Experience Subscale; ICC = intra-class correlation coefficient.
**$p < .01$.

(Hobbies, Social Activities, Sensory Experience), and the additional variance explained was 4.3% ($R^2 = .054$, adjusted $R^2 = .051$, $p < .001$; $\beta = -.209$, $p < .001$), 1.6% ($R^2 = .027$, adjusted $R^2 = .024$, $p < .001$; $\beta = -.127$, $p < .001$), 9.5% ($R^2 = .106$, adjusted $R^2 = .103$, $p < .001$; $\beta = -.308$, $p < .001$), and 2.1%($R^2 = .032$, adjusted $R^2 = .029$, $p < .001$; $\beta = -.146$, $p < .001$), respectively (see Table 2). The Food/Drink subscale scores, however, were not significant predictors of the second-wave CDI scores ($R^2 = .12$, adjusted $R^2 = .008$, $p = .428$; $\beta < -.01$, $p = .428$).

STUDY 2

Study 1 suggested that the Chinese version of the DARS has both good reliability and validity in healthy Chinese adolescents. However, the eligibility of the DARS among adolescents with depression has yet to be investigated. In Study 2, we tested the model structure and assessed the validity

and reliability of the DARS in adolescents with MDD and SD.

Methods

Participants

We recruited adolescent outpatients with MDD (aged 12–18) from a mental health center. Then, we recruited a community sample of adolescents as healthy controls (HC) and individuals with SD. The HC and SD groups were randomly selected to match the age and sex ratio of the clinical MDD group. MDD was diagnosed using the Structured Clinical Interview for DSM-IV Axis I disorders (First et al., 2002). Patients were excluded if they (1) had received modified electroconvulsive therapy in the past 6 weeks, (2) had a major medicine adjustment in the past 4 weeks, and/or (3) met other diagnoses criteria on axis I and II of the *DSM-IV*. Participants with CDI scores greater than or equal to 19 and who reported no history of MDD diagnosis were recruited as the SD group (Kovacs, 1992; Smucker et al., 1986). They were excluded if they had (1) other mental disorders of axis I or axis II based on a structured clinical interview, and/or (2) a family history of psychiatric disorders.

After removing data with poor quality (i.e., responses with missing answers or with the same answer repeatedly), 324 participants were included into the final analysis, with 108 participants in each group.

Measures and procedures

The DARS, TEPS, and CDI were completed by all participants after they had given their written informed consent to participate in the study.

Data analysis

First, data were analyzed in the same way as in Study 1 (including CFA, internal consistency, and concurrent and convergent validity of the DARS in the MDD and SD

TABLE 2 Stepwise multiple regression of re-test CDI score on demographic factors, total scale and each subscale of DARS

Model	Predictors added	R^2	Adjusted R^2	ΔF	B	*SE* B	β
1	Age	.014	.010	4.215**	−.224	.114	−.065
	Grade				−.838	.518	−.054
	Sex ratio				1.342	.523	.085*
2	DARS	.059	.055	43.537***	−.162	.025	−.213***
3	DARS-A	.031	.027	16.027***	−.339	.085	−.131***
4	DARS-B	.015	.010	.749	−.067	.077	−.029
5	DARS-C	.110	.106	98.171***	−.694	.070	−.311***
6	DARS-D	.036	.032	20.913***	−.286	.063	−.149***

Note. We use Model 1 as our baseline model, and compare Model 2–6 respectively to indicate the predictive validity of DARS's total scale and each subscale.
DARS = the Dimensional Anhedonia Rating Scale; DARS-A = DARS Hobbies Subscale; DARS-B = DARS Food and Drink Subscale; DARS-C = DARS Social Activities Subscale; DARS-D = DARS Sensory Experience Subscale.
*p < .05. **p < .01. ***p < .001.

TABLE 3 Descriptive statistics and demographic information

	Total sample (n = 324)	MDD group (n = 108)	SD group (n = 108)	HC group (n = 108)	
Age (years)	15.93	16.00	15.95	15.84	F = .262, p = .769
Sex (male : female)	1:5	1:4.7	1:4.4	1:6.2	χ^2 = .93, p = .628
Education (n)					χ^2 = 2.232, p = .328
Elementary school	8	1	3	4	
Middle school	107	44	29	34	
High school	207	61	76	70	
College	2	2	0	0	
Duration of illness (months)	4.61	13.84	/	0	
CDI	21.08	28.14	25.61	9.5	F = 223.013, p < .001
TEPS score	77.10	65.86	78.40	86.94	F = 43.896, p < .001

Note. CDI = Chinese version of the Children Depression Inventory; DARS = Chinese version of the Dimensional Anhedonia Rating Scale; HC = healthy control; MDD = major depressive disorder; SD = subthreshold depression; TEPS = Chinese version of the Temporal Experience of Pleasure Scale.

groups) using SPSS 22.0 and AMOS 21.0. Additionally, a one-way analysis of variance (ANOVA) was applied in SPSS 21.0 to test between-group differences in the DARS total and subscale scores. The significance level was set at $\alpha = .05$ for the ANOVA, and post hoc comparisons were conducted using a Bonferroni procedure.

Results

Descriptive statistics and demographics

The demographic information, and means and standard deviations of the CDI, DARS, and TEPS scores are presented in Table 3. We found no significant between-group differences in sex or age.

Confirmatory factor analysis

Given that we tested the four-factor model on a healthy sample in Study 1, CFA was also performed in the MDD and SD groups in Study 2. As in Study 1, we used a four-factor structure to test our model in the combined group including MDD and SD individuals, and all components were correlated with each other, yielding satisfactory overall fit matrices (GFI = .872, AGFI = .827, RMSEA = .076, CFI = .951, NFI = .915, TLI = .941, $\chi^2[215] = 1.232$) for the four-factor model.

Reliability analysis

The total DARS scale showed good (Cronbach's $\alpha = .947$) and high (AIC = .51) internal consistency. As expected, all

TABLE 4 Reliability of the DARS and its subscales in the three groups

	Cronbach's α				AIC			
	Total	MDD group	SD group	HC group	Total	MDD group	SD group	HC group
DARS score	.947	.935	.930	.888	.510	.460	.438	.318
DARS-A score	.944	.936	.941	.892	.807	.786	.798	.673
DARS-B score	.833	.803	.845	.711	.555	.504	.578	.381
DARS-C score	.917	.891	.901	.860	.734	.671	.696	.606
DARS-D score	.921	.908	.900	.897	.701	.665	.642	.635

Note. AIC = average inter-item correlation (an acceptable AIC should be moderate, Clark & Watson, 1995); DARS = Chinese version of the Dimensional Anhedonia Rating Scale; DARS-A = DARS Hobbies Subscale; DARS-B = DARS Food and Drink Subscale; DARS-C = DARS Social Activities Subscale; DARS-D = DARS Sensory Experience Subscale; HC = healthy control; MDD = major depressive disorder; SD = subthreshold depression.

TABLE 5 Criterion-related validity of the DARS total scale and subscales

	DARS	DARS-A	DARS-B	DARS-C	DARS-D
CDI					
Total Sample	−.591**	−.472**	−.432**	−.588**	−.479**
MDD group	−.597**	−.490**	−.440**	−.568**	−.454**
SD group	−.123	−.003	−.112	−.144	−.116
HC group	−.248**	−.213*	−.076	−.258**	−.176
TEPS-Total Scale					
Total Sample	.663**	.482**	.552**	.600**	.570**
MDD group	.709**	.570**	.531**	.597**	.605**
SD group	.479**	.259**	.383**	.467**	.395**
HC group	.399**	.074	.419**	.305**	.308**
TEPS-Anticipatory Subscale					
Total Sample	.678**	.543**	.621**	.659**	.616**
MDD group	.686**	.544**	.508**	.621**	.557**
SD group	.504**	.207*	.411**	.527**	.425**
HC group	.350**	.062	.432**	.226*	.253**
TEPS-Consummatory Subscale					
Total Sample	.557**	.481**	.487**	.512**	.521**
MDD group	.625**	.529**	.454**	.474**	.564**
SD group	.369**	.288**	.282**	.323**	.281**
HC group	.347*	.038	.308**	.310**	.295**

Note. DARS = Chinese version of the Dimensional Anhedonia Rating Scale; DARS-A = DARS Hobbies Subscale; DARS-B = DARS Food and Drink Subscale; DARS-C = DARS Social Activities Subscale; DARS-D = DARS Sensory Experience Subscale; HC = healthy control; MDD = major depressive disorder; SD = subthreshold depression; TEPS = Chinese version of the Temporal Experience of Pleasure Scale; TEPS-Anticipatory = TEPS-Anticipatory Subscale; TEPS-Consummatory = TEPS-Consummatory Subscale.
*$p < .05$. **$p < .01$.

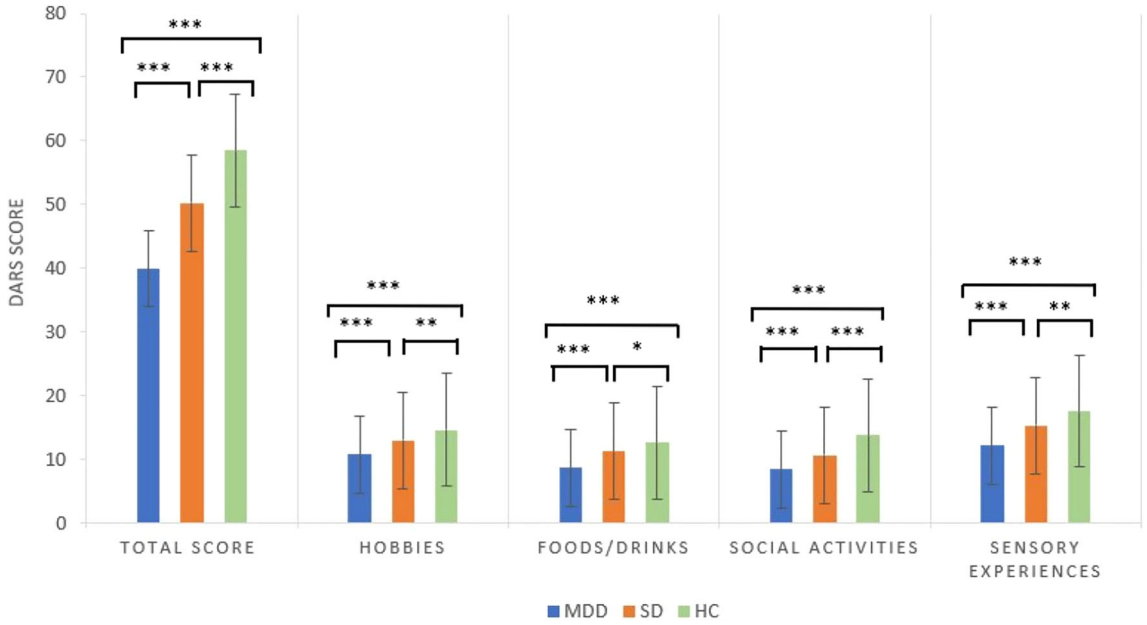

FIGURE 3 Differences in the total and subscale DARS scores between the MDD, SD, and HC groups. *Note*. MDD = major depressive disorder; SD = subthreshold depression; HC = healthy control. $^{*}p < .05$, $^{**}p < .01$, $^{***}p < .001$

subscales within each group showed good internal reliability (Cronbach's α = .711 and .947; AIC: .318 and.807; see Table 4 for details).

Validity analysis

For the convergent validity, in the MDD group, the DARS total score demonstrated moderate to high correlations with the TEPS scores ($r = -.709$, $p < .01$). All DARS subscale scores also displayed moderate to high correlations with the TEPS scores (see Table 5). Within the SD group, the DARS total and subscale scores were moderately correlated with the TEPS total score ($rs = .479$, $p < .01$). The subscale DARS scores were weakly to moderately correlated with the TEPS total score (see Table 5). Within the HC group, the total and subscale DARS scores were weakly correlated with the TEPS score (see Table 5).

For the concurrent validity, in the MDD group, similarly, the DARS total score demonstrated moderate to high correlations with the CDI ($r = -.597$, $p < .01$). All DARS subscale scores also showed moderate to high correlations with the CDI (see Table 5). However, within the SD group, we found no significant correlation between the DARS total score and CDI scores ($r = -.123$, $p > .05$). Similarly, none of the DARS subscale scores were significantly associated with the CDI. Within the HC group, the total and subscale DARS scores had weak correlations with the CDI (see Table 5).

As shown in Figure 3, there was a significant between-group difference in the DARS total score ($F[2, 321] = 64.756$, $p < .001$), whereby the MDD group had significantly lower scores than the other two groups ($ps < .001$), and the SD group had lower scores than the HC group ($p < .001$). As expected, we also observed a similar pattern of between-group differences in all four DARS subscale scores.

DISCUSSION

The aim of the current study was to validate the Chinese version of the DARS in typical and depressed adolescents. In Study 1, the Chinese version of the DARS yielded a reliable four-factor structure that included the domains of hobbies, food and drink, social activities, and sensory experience in typical adolescents. Moreover, the DARS had good internal and test–retest reliability, as well as concurrent, convergent, and divergent validity. In Study 2, the CFA indicated an acceptable to good fit for the four-factor model in the combined MDD and SD groups. There were significant between-group differences in the total and subscale DARS scores, with the MDD group showing a higher level of state anhedonia than the SD group, whose scores were higher than the HC group, which suggests a good eligibility of the DARS in the depression sample.

For construct validity, the CFA indicated a good fit to the four-factor structure model in typical Chinese adolescents and individuals with MDD and SD. In line with our findings, previous studies have also reported that the DARS has a robust four-factor structure in adults with a different cultural background, such as Canadian, Spanish, German, and Chinese settings (Arrua-Duarte et al., 2019; Jia et al., 2020;Rizvi et al., 2015; Wellan et al., 2021). This suggests that the four-factor structure of the DARS is invariable and universal across different ages and cultural backgrounds. Furthermore, our findings in Study 2 again yielded a four-factor model in adolescents with MDD and SD, which is consistent with previous

researches suggesting that the four-factor structure model is applicable in adults with MDD (Arrua-Duarte et al., 2019; Jia et al., 2020). To our knowledge, the present study is the first to assess the eligibility of the DARS in both adolescents with MDD and those with SD.

In regard to criterion validity, the significant moderate to high correlations between the DARS, TEPS, and BAS scores in Study 1 and Study 2 support prior evidence (Arrua-Duarte et al., 2019; Rizvi et al., 2015), which corroborates the high convergent validity of the DARS to detect anhedonia experience with regard to desire/anticipatory pleasure, motivation, effort, and consummatory pleasure components. In particular, the strong correlations of anticipatory and consummatory sub-scores of the TEPS with the DARS total and subscale scores signifies the ability of the DARS to capture state anhedonia across multiple hedonic domains, such as anticipatory (Geaney et al., 2015) and consummatory/in the moment pleasure (Martinotti et al., 2012). Moreover, the DARS demonstrates good divergent validity, as its correlations with the BIS scores were small to none. The BIS scale has been linked to dysfunctional impulsive-related behaviors, which is completely different from the construct of anhedonia (Rizvi et al., 2015; Wellan et al., 2021).

After controlling the influence of demographic variables, the second-wave CDI scores was significantly predicted by the first-wave DARS total and three subscale scores (i.e., hobbies, social activities, and sensory experience). This finding further revealed good predictive validity of the DARS. In Study 2, the DARS scores were evidenced to be related to CDI scores in adolescents with MDD. More interestingly, as expected, we further observed that the SD group reported significantly higher total DARS scores than the MDD group, but lower scores than the HC group. Notably, a large body of existing literature has supported the feasibility of a depression spectrum by indicating that individuals with SD and MDD shared symptom presentations (e.g., sad mood, anhedonia, low energy), but that those with SD had less severe depression symptoms than patients with MDD (Bertha & Balázs, 2013; Rodríguez et al., 2012; Rohde et al., 2009; Wesselhöft, 2016). One study that recruited participants in 29 countries revealed a consistent pattern of risk factors across all subtypes of SD and MDD (Ayuso-Mateos et al., 2010). Furthermore, longitudinal studies have reported that the history of experiencing SD is associated with an increased risk for a subsequent MDD episode in adolescents (Angst & Merikangas, 1997; Rohde et al., 2009). Therefore, the difference in DARS scores between the three groups may support the idea that there is a continuum of the depressive spectrum and functioning, thus affirming that the DARS is a sensitive tool to detect altered hedonic function in individuals with depressive spectrum disorders.

However, beyond our expectations, the correlations between the CDI and the DARS total and subscale scores in the SD group were unsatisfactory. We speculate the heterogeneity of the characteristics of subthreshold depression might underlie the non-significant result aforementioned (Rodríguez et al., 2012). Specifically, here is one subtype of SD, namely subsyndromal symptomatic depression SSD, characterized by two or more depression symptoms except depressed mood and anhedonia (Sadek & Bona, 2000). This subtype (with no obvious anhedonia symptoms) has been found to have a higher 1-month point prevalence (3.9%) than other SD subtypes (minor depression, 1.9%; dysthymia, 2.3%) (Judd et al., 1997). Moreover, the findings that anhedonia is one of the least severe symptoms reported in people who experienced subthreshold depression (Rohde et al., 2009), might explain why anhedonia was only weakly correlated with overall depression in SD teenagers. Nevertheless, the Chinese version of the DARS exhibited good construct, convergent, discriminant, and predictive validity in the Chinese adolescent setting, which demonstrates that the state anhedonia measured by the DARS in adolescents is comparable with that measured in adults; this in turn broadens the applicable age range of the DARS.

Moreover, the high internal consistency (Cronbach's $\alpha = .79$ to $.91$) of the total and subscale DARS scores in adolescents was found, which is in line with previous findings in Canadian (Cronbach's $\alpha = .75$ to $.92$; Rizvi et al., 2015), Spanish (Cronbach's $\alpha = .91$ to $.92$; Arrua-Duarte et al., 2019), German (Cronbach's $\alpha = .76$ to $.86$; Wellan et al., 2021), and Chinese (Cronbach's $\alpha = .89$ to $.97$; Jia et al., 2020) adults. Regarding the test–retest reliability, the ICC for the total DARS scale and its subscales, ranging from .616 to .741, indicated acceptable stability of the DARS validity over 3 months in Chinese adolescents. Among the existing studies that have assessed psychometric properties of the DARS, only one Chinese study in adults evaluated the test–retest reliability after 1 week, and reported relatively high values that ranged from .89 to .97, which is higher than that reported in the present study (Jia et al., 2020). Although the test–retest reliability of the present study was not as high as that reported by Jia et al., it is still meaningful, as a longer retest interval may introduce more residuals, thus pulling down the test–retest reliability, which is common and understandable in psychometrics (Rozgonyi et al., 2021).

Considering the prominent advantages of DARS, this scale could be a prominent measurement in screening individuals at high risk of depression. First, the significant between-group differences in the total and subscale DARS scores indicates that state anhedonia is manifested in individuals with subthreshold and clinical depression over a wide range of domains, including hobbies/pastimes, food/drinks, social activities, and sensory experiences. This is in line with notion that amotivation to obtain rewards and decreased pleasure from reward experience have been shown to be cardinal depressive symptoms (Treadway & Zald, 2012; Watson et al., 2020), which may result in withdrawal from hobbies or pastimes (Ernst, 2012), pleasurable sensory experience across varied modalities such as olfaction, gustation, and audition (Rochet et al., 2018) and real-life social activities (Frey & McCabe, 2020). It thus offers an opportunity to detect subtle changes in reward processing. Second, the DARS scores significantly predicted the CDI scores in 3 months, suggesting that the DARS could be a reliable toolkit for early detection of potential depression symptoms. Third, adolescence is a period with elevated depression risk and also hypersensitive reward system (Forbes & Dahl, 2012; Galvan, 2010; Thapar et al., 2012). Compared

with other age groups, it would be easier to identify differences between the common heightened reward function in typically-developing adolescents and the altered reward system related to depression. Additionally, current treatments barely take reward system into consideration even though anhedonia is associated with adverse prognosis (McMakin et al., 2012). The role the DARS played in identifying varied reward processing impairment might promote the development of personalized psychological counseling or interventions to adolescent depression.

Although robust evidence for the structure validity and reliability of the DARS was obtained, the present study has some limitations. First, the age range (15–18 years) of the typical adolescent sample in Study 1 was rather narrow. The absence of participants in early adolescence (i.e., 12–15 years) in the sample may limit the generalization of our findings to the whole of adolescence. Second, due to the high attrition rate of patients with MDD, we were unable to assess the test–retest reliability in Study 2. Further studies should pay more attention to the effectiveness of the DARS in clinical samples over time, and the applicability of the DARS to all ages. Third, the results in our study showed that DARS measure a general concept of state anhedonia rather than specific components of reward processing such as desire/interest, anticipation, effort, and consummatory pleasure as expected. Future effort is needed to develop a scale covering the specific reward processing aforementioned in adolescence.

In conclusion, the findings suggest that the Chinese version of the DARS is a reliable and valid measure to evaluate state anhedonia across different domains in typical and depressed adolescents. Thus, the DARS might serve as an alternative measurement to capture aberrant state hedonic experiences among both clinical and non-clinical adolescents, thus providing a potentially effective means of early detection of adolescent depression.

DISCLOSURE OF CONFLICTS OF INTEREST

The authors declare that there are no conflicts of interest.

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