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ORIGINAL RESEARCH

Psychometric Properties of Different Short Forms of Social Interaction Anxiety Scale in Chinese College Students

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Background: There exist four short forms of the Social Interaction Anxiety Scale (SIAS): 10-item version (SIAS-10), 6-item version by Peters et al (SIAS-6P), 6-item version by Fergus et al (SIAS-6F), and 5-item version (SIAS-5). This study aims to comprehensively examine the psychometric properties of the SIAS-10, SIAS-6P, SIAS-6F, and SIAS-5 and to determine which one performs relatively better in Chinese population.

Methods: This study enrolled 733 Chinese college students. The unidimensionality of the SIAS-10, SIAS-6P, SIAS-6F, SIAS-5 was examined using Confirmatory Factor Analysis (CFA). Multi-Group CFA was further adopted to assess measurement equivalence across gender. Internal consistency reliability and criteria-related validity were also evaluated. Additionally, the measurement performance of the SIAS-10, SIAS-6P, SIAS-6F, and SIAS-5 was assessed with Item Response Theory (IRT), which estimated the discrimination parameter and the Item Characteristic Curve (ICC) for each item.

Results: Except for the SIAS-5, the SIAS-10, SIAS-6P, and SIAS-6F displayed a good-fit to the one-factor model. Furthermore, the SIAS-10 achieved strict equivalence across gender while other versions did not. The SIAS-10, SIAS-6P, SIAS-6F and SIAS-5 all had acceptable internal consistency and significant correlations with criteria scales. The IRT results showed that the SIAS-10 included more items with higher discrimination and peaked ICCs (indicating more informative), whereas the SIAS-6P included more items with lower discrimination and flat ICCs (indicating less informative).

Conclusion: For assessing social anxiety in Chinese under constrained conditions, the SIAS-10 is recommended to clinicians for it measuring equivalently across gender, reflecting the relevant criteria variables well, and discriminating various levels of social anxiety sensitively.

Keywords: social anxiety, psychometric properties, measurement equivalence, item response theory, Chinese

Introduction

Social Anxiety Disorder (SAD) is characterized by excessive anxiety in social situations (eg, talking to others, taking part in a party) that invoke feelings of being scrutinized by others and fears of negative evaluation from others.[1] It has been estimated that SAD had a lifetime prevalence of 0.7% in China.[2] According to a recent survey among Chinese college students, over one-third reported experiencing at least one symptom of social anxiety.[3] Individuals suffering from social anxiety had a perception of decreasing quality of life,[4] with impairment in interpersonal relationships[5,6] and occupational functioning.[7] The burden of social anxiety underscores the importance of timely intervention, which issues a warrant to develop valid instruments to assess social anxiety.

As a prevailing method to assess social anxiety, self-report scale has the advantages of saving time and minimizing error variance due to multiple assessors.[8,9] A magnitude of self-report scales has been developed to assess social anxiety, such as the Social Phobia and Anxiety Inventory,[10] the Social Phobia Inventory,[11] the self-report version of Liebowitz Social Anxiety Scale.[12] These scales tend to measure social anxiety adopting a generalized perspective, whereas the Social Interaction Anxiety Scale (SIAS)[13] specifically focuses on fears of mixing or interacting with others (eg, eye contact, communication, dating, etc.) rather than being scrutinized or performing in public (eg, making a speech in public).

The SIAS was typically applied by clinicians and researchers to assess the severity of social anxiety symptoms, especially that induced by interpersonal interactions, to identify social anxiety cases,[14] and to evaluate the treatment outcomes.[15] The SAIS has been developed into different translation versions, such as Spanish,[16] German,[17] Swedish,[18] Japanese and Australian,[19] and Chinese.[20] To be noticed, there are multiple versions of the SIAS among its wide-spreading applications. A total of twenty items constructed the earliest form of the SIAS (SIAS-20), which was recorded in the unpublished research of Mattick and Clarke in 1989. However, when the SIAS was formally published in 1998, its creators had already deleted item 5 and therefore led to the 19-item version (SIAS-19).[13] Then, further studies demonstrated that the three reversely scored items (ie, item 5, item 9, and item 11) impaired the soundness of the factor structure of SIAS-20[21–23] Subsequently, Rodebaugh et al proposed that what these three items measured was extroversion rather than the absence of social anxiety, and then recommended the 17-item straightforward version of the SIAS (SIAS-17).[24] Meanwhile, some researchers tried to shorten the SIAS to facilitate its use. So far, there have been four short forms of the SIAS (SIAS-10, SIAS-6P, SIAS-6F, and SIAS-5) originating from different full versions.[25–28]

The earliest short form was SIAS-5, which was developed by Carleton et al and included five items (see Table 1) from the SIAS-19 with the principle of maintaining a robust and stable factor structure.[25] Later, another abbreviated version was developed by Kupper and Denollet[27] from the SIAS-19, retaining ten items (SIAS-10; see Table 1) after deleting items that both possessed low item-total correlations and hardly undermined Cronbach's α if deleted. Although the efficiency of the SIAS-5/SIAS-10 in measuring social anxiety was demonstrated, respectively,[25,27,29] these two short forms have not been used widely. There exist another two relatively popular short forms. Peters et al developed a six-item

Table 1 Component Items of Different Versions of the SIAS

SIAS-20	SIAS-19	SIAS-17	SIAS-10	SIAS-6P	SIAS-6F	SIAS-5
1	√	√				
2	√	√	√	√		
3	√	√			√	
4	√	√		√		
5						
6	√	√		√	√	
7	√	√	√			√
8	√	√	√	√	√	
9	√					
10	√	√	√	√		√
11	√					
12	√	√	√			
13	√	√		√		
14	√	√				
15	√	√	√			√
16	√	√	√		√	√
17	√	√	√			
18	√	√	√		√	
19	√	√	√		√	√
20	√	√				

Abbreviation: SIAS, Social Interaction Anxiety Scale.

version (SIAS-6P; see Table 1) on the purpose of obtaining a short form sensitive to varying levels of social anxiety.[28] Meanwhile, Fergus et al extracted six items (SIAS-6F; see Table 1) from the SIAS-17 with particular attention to readability.[26] Both of the SIAS-6P and SIAS-6F have been reported to show adequate reliability and validity.[26,28] In practice, the existence of multiple short forms might potentially increase difficulties in conclusions generalization.[30] Hence, to provide more evidence for clinicians and researchers to select relatively better one from the SIAS-10/SIAS-6P/ SIAS-6F/SIAS-5 under constrained conditions, examining and contrasting their psychometric properties comprehensively is of significant importance.

Some previous studies have made analogous attempts between the SIAS-6P and SIAS-6F. Le Blanc et al examined the psychometric properties of the SIAS-6P and SIAS-6F employing a SAD sample and a non-anxious control sample.[31] Their results suggested that both the SIAS-6P and SIAS-6F possessed adequate internal consistency, good convergent validity, sufficient diagnosis sensitivity, and high efficiency to predict the treatment outcomes.[31] This similarly good performance of the SIAS-6P and SIAS-6F was replicated in a subsequent study, which additionally verified that both measured social anxiety across American and Korean sample with identical loadings.[32] Although these findings supported tenable psychometric properties for both the SIAS-6P and SIAS-6F, some slight differences in psychometric performance between the SIAS-6P and SIAS-6F shed light on selecting a relatively better SIAS short form. Specifically, the SIAS-6F displayed better incremental validity than the SIAS-6P across several criteria variables,[32] and the SIAS-6P displayed a good fit to data but the SIAS-6F did not.[33] A recent cross-culture study found that the SIAS-6P achieved strong measurement equivalence across American and Chinese individuals, whereas the SIAS-6F did not.[34]

In several studies, all short forms of the SIAS were included to compare their psychometric properties comprehensively, and some slight differences were discovered.[20,30,35] Referring to the structural validity, Ouyang et al found that the SIAS-6P had the most tenable unidimensional structure rather than the SIAS-10, SIAS-6F, and SIAS-5.[20] About the convergent validity, Carleton et al found that the correlation between the SIAS-6P and the Brief Fear of Negative Evaluation Scale (BFNE) was significantly weaker than those between the SIAS-10/SIAS-6F/SIAS-5 and the BFNE.[30] For the sensitivity to treatment, Carleton et al reported that the SIAS-6F manifested larger effect size in detecting social anxiety changes during treatment than the SIAS-10, SIAS-6P, and SIAS-5,[30] while Erceg-Hurn and McEvoy pointed out that the SIAS-5 was over-sensitive and the SIAS-6P was inefficient in detecting treatment outcomes.[35] Notably, Erceg-Hurn and McEvoy also used item analysis and disclosed the poor performance of the SIAS-6P and the SIAS-5 at item level.[35] Specifically, through calculating the component items' Mean and Standard Deviation and then analyzing their ranks in the SIAS-20, Erceg-Hurn and McEvoy discovered that the over-sensitivity to treatment of the SIAS-5 could be attributed to its inflated variance and the bad sensitivity to treatment of the SIAS-6P could be explained by its ceiling effect.[35] Therefore, evaluating and comparing the psychometric properties among these SIAS short forms just at scale level could not provide enough evidence for selecting a better short form.

Actually, item analysis has been frequently used to develop the SIAS short forms.[25–28] However, few studies have examined the psychometric properties of different SIAS short forms at item level. Although Erceg-Hurn and McEvoy applied the item analysis to explore the poor performance of the SIAS-6P and SIAS-5, they just used two indices of item analysis (Mean and Standard Deviation of each item),[35] which could not provide enough psychometric information at item level and had the risk of preliminarily assuming that the items were equally estimated across the latent continuum.[36]

As Embretson & Reise suggested, more information at item level could be gotten by the Item Response Theory (IRT), which is a measurement framework relating the observed responses to the latent trait based on various mathematical models.[37] Each item could be evaluated how effective at discriminating individuals with various levels across a latent trait continuum according to its item response function, which predicts participant's response by the person's trait and the item characteristics. Actually, the psychometric performance of the SIAS-6P had been explored with the IRT method in several studies.[20,38] However, there is still a lack of IRT studies analyzing the SIAS-10/SIAS-6F/SIAS-5 and comparing comprehensively the psychometric properties of all short forms at item level, which is worthwhile in that the four short forms have few items overlapping with each other (see Table 1).

Thus, our study aimed to comprehensively examine and compare the psychometric properties of the SIAS-10/SIAS-6P/SIAS-6F/SIAS-5 and further clarify which one performs relatively better in Chinese population. Firstly, we focused on the regular psychometric properties including the factor structure, the internal consistency reliability, and the criteria-

related validity. Additionally, in light of the potential contribution resulting from the inequivalence of the scale to the conclusions on gender differences in social anxiety,[27,39] the measurement equivalence of one-factor model across gender was also examined in this study. At last, further analysis at item level was executed with the IRT method to provide more psychometric information for the SIAS-10/SIAS-6P/SIAS-6F/SIAS-5.

Materials and Methods
Participants
A total of 733 participants were recruited from two universities in Hunan Province of China, using a convenience sampling method through posters and advertisements. Data collection lasted for four months from February 2022 to June 2022. Before recruitment, we calculated that enrolling 202 participants would achieve adequate statistical power (95%, α = 0.05, two-tailed) and an anticipated intraclass correlation coefficient (ICC) value of 0.25,[40] using G*power software for the calculations.[41] The inclusion criteria of participants were: (1) able to communicate, read, write; (2) willing to participate and sign the informed consent. The exclusion criteria of participants were: (1) with current or past psychiatric disorders; (2) with physical disabilities. The age of participants ranged from 16 to 28 years, and the mean age was 21.46 (SD=1.96). The females and males comprised 69.99% and 30.01% of the sample, respectively. For the entire sample, 52.80% of participants reported that they came from urban areas, while the remainder from rural areas. In addition, the majority of this sample identified themselves as Han nationality (N=672; 91.68%). Each participant was administered to complete a packet of self-reported questionnaires (details in the following part).

This study was approved by the Ethics Committee of Second Xiangya Hospital of Central South University. All participants gave informed consent before engagement, and the two under 18 years old were approved to give consent on their own behalf.

Instruments
Social Interaction Anxiety Scale (SIAS)
This original full scale comprises 20 items concerning the feelings related to different interpersonal interaction contexts (eg, *I feel tense if I am alone with just one person*). A five-point Likert rating scale (0=not at all, 4=extremely) is employed for respondents to assess the extent how much they agree with each item.[24] As such, individual who scores higher is estimated as suffering from more severe social interaction anxiety. In this study, we utilized the 20-item Chinese version of SIAS, which was validated by Zhu et al[42,43] Notably, the 20-item SIAS includes 3 reversely scored items (item 5, item 9, and item 11) which has been argued to measure extroversion rather than a lack of social anxiety. Therefore, the SIAS-17 was selected as the full Chinese version in this study.

A total of four short forms of the SIAS were included into analyses: (1) abbreviated version of the SIAS by Kupper and Denollet (10 items, SIAS-10); (2) Peters' short form of the SIAS (6 items, SIAS-6P); (3) Fergus' short form of the SIAS (6 items, SIAS-6F); (4) Carleton's short form of the SIAS (5 items, SIAS-5). The detailed component items of every short form are shown in Table 1. It is noteworthy that the SIAS-20 was fulfilled by participants in this study, and data of the SIAS-17/SIAS-10/SIAS-6P/SIAS-6F/SIAS-5 was then retrieved from the responses to the SIAS-20. In addition, the serial number in SIAS-20 was adopted to name individual item in this study.

Instruments for Criteria-Related Validity
State-Trait Anxiety Inventory (S-TAI)
The S-TAI assesses both the temporary anxious state (State Anxiety Inventory, SAI) and the general anxious trait (Trait Anxiety Inventory, TAI).[44] Each subscale includes twenty items scored on a 4-point Likert scale (SAI: 1=not at all, 4=very much so; TAI: 1=almost never, 4=almost always), with higher scores reflecting increased level of anxiety. The Chinese version of the S-TAI has shown acceptable reliability and validity.[45] In this study, the Cronbach's α of SAI and TAI was 0.93 and 0.91, respectively.

Worry Domains Questionnaire-Short Form (WDQ-SF)
The WDQ-SF is a 10-item instrument focusing on both pathological and nonpathological worry across a variety of

domains with a 5-point Likert scale (0=not at all, 4=extremely), with higher scores in the corresponding domains indicating higher levels of worry in those areas.[46] The Chinese version of WDQ-SF has favorable internal consistency.[47] The Cronbach's α of WDQ-SF was 0.92 in our sample.

Neuroticism Subscale of the NEO-PI (NEO-PI-N)

The Neuroticism-Extraversion-Openness Personality Inventory (NEO-PI) consists of 240 items rated on a 5-point Likert scale (1=strongly disagree, 5=strongly agree).[48] The 48-item neuroticism subscale of NEO-PI was adopted in this study to evaluate participant's level of neuroticism, with higher scores suggesting higher levels of neuroticism. The Chinese version of NEO-PI has shown good psychometric properties.[49] Its Cronbach's α in this study was 0.89.

Attachment Style Questionnaire (ASQ)

The ASQ is a 40-item survey to investigate individual's attachment style with three dimensions: insecure-anxiety, insecure-avoidance, attachment-secure.[50,51] Participants rate each item on a 6-point Likert scale (1=totally disagree, 6=totally agree). In this study, two insecure dimensions were adopted as the insecure attachment subscale (ASQ-I, 32 items), with higher scores implying greater levels of insecure attachment. The Chinese version of ASQ has indicated good internal consistency.[52] The Cronbach's α of ASQ-I was 0.93 in our sample.

Data Analyses

Confirmatory Factor Analysis

The one-factor structure of the SIAS-17/SIAS-10/SIAS-6P/SIAS-6F/SIAS-5 was examined with the Confirmatory Factor Analysis (CFA), respectively. The Robust Maximum Likelihood method was adopted as the parameter estimator of CFA. Technically, the insignificance of the χ^2 test indicates that the supposed model fits the data. However, the value of χ^2 was not available to estimate the model fit because of its oversensitivity to sample size.[53] Thus, to evaluate model fit, we used the following indices: (1) Comparative Fitness Index (CFI), a value of 0.900 or greater is acceptable; (2) Tucker-Lewis Index (TLI), a value of 0.900 or greater is acceptable; (3) Standardized Root Mean Squared Residual (SRMR), a value of 0.080 or lower is acceptable; (4) Root Mean Square Error of Approximation (RMSEA), a value of 0.080 or lower is acceptable.[54] In general, when all these indices meet the cutoffs, the factor model would be evaluated as good-fit.

Measurement Equivalence

The measurement equivalence across gender for those short forms with good-fit in CFA was further tested using Multi-group CFA (MGCFA). Through establishing four multi-group factor structure models, we tested four levels of measurement equivalence correspondingly: (1) Configural equivalence: the loadings and intercepts are estimated freely in this model; (2) Weak equivalence: the loadings are constrained equal across groups while the intercepts are free; (3) Strong equivalence: this model fixes both loadings and intercepts equal across groups. (4) Strict equivalence: residual variances are additionally set identical across groups.[55] These models are nested, namely that the higher level of equivalence can be further examined only if the lower level of equivalence is proved.[55] Generally speaking, the corresponding level of equivalence is confirmed when the χ^2 difference testing between two adjacent models is demonstrated insignificant. And the changed value of CFI also serves as the index evaluating the measurement equivalence: ΔCFI<0.010 implies acceptable.[56]

Internal Consistency Reliability Analysis

Cronbach's α was calculated to assess the internal consistency reliability. As a complement to the conventional index, the McDonald's ω was also reported, which has been thought more accurate in assessing reliability, especially for unidimensional scale.[57] This study also computed the Mean of the Inter-item Correlation (M_{IC}), and a range of 0.10–0.50 was recommended.[58]

Correlation Analysis and Coefficients Comparison

The Pearson correlation coefficients with SAI, TAI, WDQ-SF, NEO-PI-N, and ASQ-I were calculated to evaluate the criteria-related validity of each version of the SIAS. Using a formula applicable to compare two dependent correlations,[59]

we examined whether SIAS-10/SIAS-6P/SIAS-6F/SIAS-5 had a comparable correlation in magnitude with the criteria measures relative to the SIAS-17.

Item Response Theory Analysis

To reveal more psychometric details of the SIAS at the item level, Item Response Theory (IRT) was conducted on the platform IRTPRO 2.1.[60] In this study, the IRT analysis was based on the Graded Response Model (GRM), a mathematical model appropriate for Likert-type items.[61] For each item, GRM estimates one discrimination parameter (a) and K-1 (K refers to the number of options, eg, K for SIAS=5) threshold parameters (b1, b2, b3, b4). The discrimination parameter of item indicates its sensitivity to the difference between respondents with various levels of the target trait (θ). The threshold parameter indicates the level of θ needed for a person to choose one response option rather than one of the options below it. Meanwhile, the IRT results can be presented graphically: (1) the Option Characteristics Curves (OCCs) reflect the probability of responding in a particular response category across the continuum of latent trait; (2) the Item Characteristics Curve (ICC) depicts how much information the item contains across the latent trait continuum.[62,63]

In this study, we focused on how much information each item contributed to the overall information captured by the SIAS-17 relative to other items. Specifically, the performance of each item was evaluated with the value of discrimination parameter and the features of OCCs and ICC. Regarding discrimination parameter (a), a range of 0.65–1.34 indicates moderate discrimination, 1.35–1.69 indicates high discrimination, and larger than 1.69 indicates very high discrimination.[63] According to the features of OCCs and ICC, each item was dichotomously marked as more informative or less informative. The more informative item possesses OCCs with the following features: exhibiting a peak for one option and not being covered by the curves of other options. Such characteristics is obscure in the OCCs of less informative items, which suggests that individuals with different levels of θ tend to have a similar likelihood of endorsing the same option on this item.[62] As to ICC, the item yielding a low and flat information curve (ie, gathering little information at all levels of θ) implies less informative, whereas the item with a peaked ICC implies more informative.[64]

Results

CFA results

The CFA results of the SIAS-17/SIAS-10/SIAS-6P/SIAS-6F/SIAS-5 are presented in Table 2. The SIAS-17 failed to meet the fitting criteria (CFI=0.892, TLI=0.877). Among the short versions examined, only the unidimensional model of the SIAS-5 did not fit to data well (RMSEA=0.082), whereas the one-factor model of the SIAS-10/SIAS-6P/SIAS-6F fitted to data well (all CFI>0.950, TLI>0.930, SRMR< 0.040, RMSEA<0.080).

Results of Measurement Equivalence Across Gender

Both the SIAS-17 and SIAS-5 were not included in this part considering that the adequate model fit was essential to further measurement equivalence tests. Table 3 summarizes the results of CFA in the male/female group and the results of MGCFA at four measurement equivalence levels for the SIAS-10/SIAS-6P/SIAS-6F.

Table 2 Fit Indices for the Unidimensional Structures of Different Forms of the SIAS

	χ^2	*df*	CFI	TLI	SRMR	RMSEA	90% CI	
SIAS-17	537.296***	119	0.892	0.877	0.049	0.069	0.063	0.075
SIAS-10	132.353***	35	0.954	0.941	0.036	0.062	0.051	0.073
SIAS-6P	20.311***	9	0.984	0.973	0.022	0.041	0.017	0.066
SIAS-6F	43.415***	9	0.960	0.933	0.034	0.072	0.052	0.094
SIAS-5	29.534***	5	0.970	0.941	0.028	0.082	0.055	0.111

Note: ***p<0.001.
Abbreviations: SIAS, Social Interaction Anxiety Scale; CFI, Comparative Fitness Index; TLI, Tucker-Lewis Index; SRMR, Standardized Root Mean Squared Residual; RMSEA, Root Mean Square Error of Approximation; CI, Confidence Interval.

Table 3 Measurement Equivalence Across Gender of the SIAS-10, SIAS-6P and SIAS-6F

		χ^2	df	CFI	TLI	SRMR	RMSEA	90% CI		$\Delta\chi^2$	ΔCFI
SIAS-10	Male	59.323	35	0.962	0.951	0.043	0.056	0.030	0.080		
	Female	110.799	35	0.950	0.936	0.038	0.065	0.052	0.079		
	Configural	163.957	70	0.955	0.942	0.039	0.061	0.049	0.073		
	Weak	176.228	79	0.953	0.947	0.046	0.058	0.046	0.069	8.655	0.002
	Strong	192.432	88	0.950	0.949	0.048	0.057	0.046	0.068	14.89[a]	0.003
	Strict	201.372	98	0.950	0.954	0.051	0.054	0.043	0.064	8.614	0.000
SIAS-6P	Male	13.178	9	0.978	0.964	0.034	0.046	0.000	0.095		
	Female	16.210	9	0.986	0.977	0.022	0.040	0.024	0.070		
	Configural	29.074	18	0.984	0.973	0.026	0.041	0.004	0.067		
	Weak	40.935	23	0.974	0.966	0.051	0.046	0.021	0.069	13.029*	0.010
	Strong	-	-	-	-	-	-	-	-	-	
	Strict	-	-	-	-	-	-	-	-	-	
SIAS-6F	Male	9.221	9	0.999	0.999	0.028	0.011	0.000	0.077		
	Female	38.136	9	0.949	0.915	0.037	0.079	0.054	0.106		
	Configural	43.066	18	0.969	0.948	0.035	0.062	0.038	0.086		
	Weak	48.665	23	0.968	0.958	0.039	0.055	0.033	0.077	2.748	0.001
	Strong	62.383	28	0.957	0.954	0.042	0.058	0.039	0.077	23.140***	0.011
	Strict	-	-	-	-	-	-	-	-	-	

Notes: [a]p=0.094. *p<0.05. ***p<0.001. χ^2 estimated by the Robust Maximum Likelihood (MLR); Value of $\Delta\chi^2$ computed with adjusted χ^2.
Abbreviations: SIAS, Social Interaction Anxiety Scale; CFI, Comparative Fitness Index; TLI, Tucker-Lewis Index; SRMR, Standardized Root Mean Squared Residual; RMSEA, Root Mean Square Error of Approximation; CI, Confidence Interval.

The SIAS-10 exhibited measurement equivalent across gender at the configural, weak, strong, and strict equivalence level, in that the successive models displayed insignificant difference in the value of χ^2 (ps>0.05) and little changed value of CFI (all ΔCFI<0.010). For the SIAS-6P, the equal factor structure was evidenced by the adequate fitness at the configural level. However, the weak equivalence was not met according to the adjusted χ^2 difference test being significant ($\Delta\chi^2$=13.029, Δdf=5, p<0.05) and the changed value of CFI failing to achieve the acceptable standard (ΔCFI=0.010). The SIAS-6F possessed measurement equivalence across gender at the configural model, and its weak equivalence across gender was also established ($\Delta\chi^2$=2.748, Δdf=5, p=0.739, ΔCFI=0.001), but the strong equivalence was not met because the adjusted χ^2 at the strong model level significantly differed with that at the weak level ($\Delta\chi^2$=23.140, Δdf=5, p<0.001) and the changed value of CFI exceeded the acceptable standards (ΔCFI=0.011).

Results of Internal Consistency Reliability

As shown in Table 4, the SIAS-17 displayed excellent internal consistency (Cronbach's α=0.92). The SIAS-6P possessed acceptable internal consistency (Cronbach's α=0.79), whereas the SIAS-10/SIAS-6F/SIAS-5 all showed good internal consistency (Cronbach's α: 0.82–0.90). The results of McDonald's ω were similar to those of Cronbach's α (see Table 4). The M_{IC} values of the SIAS-17, SIAS-10, SIAS-6P, SIAS-6F, and SIAS-5 ranged from 0.39 to 0.50.

Table 4 Internal Consistency Reliability of Different Forms of the SIAS

	SIAS-17	SIAS-10	SIAS-6P	SIAS-6F	SIAS-5
Cronbach's α	0.92	0.90	0.79	0.82	0.83
McDonald's ω	0.92	0.90	0.80	0.82	0.83
M_{IC}	0.41	0.46	0.39	0.43	0.50

Abbreviations: SIAS, Social Interaction Anxiety Scale; M_{IC}, Mean of the Inter-item Correlation.

Table 5 Correlations with Criteria-Related Variables of Different Forms of the SIAS and Coefficients Difference Test Between Short Forms and SIAS-17

	SAI		TAI		WDQ-SF		NEO-PI-N		ASQ-I	
	r	Z	r	Z	r	Z	r	Z	r	Z
SIAS-17	0.44***	-	0.53***	-	0.50***	-	0.52***	-	0.56***	-
SIAS-10	0.43***	0.92	0.53***	0.00	0.50***	−0.14	0.52***	0.28	0.55***	0.13
SIAS-6P	0.45***	−0.84	0.53***	0.15	0.46***	2.49*	0.47***	3.95***	0.52***	2.33*
SIAS-6F	0.42***	1.27	0.51***	2.20*	0.44***	5.37***	0.48***	3.59***	0.52***	3.59*
SIAS-5	0.42***	1.34	0.51***	1.75ᵃ	0.46***	3.32***	0.48***	3.61***	0.51***	3.61**

Notes: ᵃp =0.080. *p<0.05. **p<0.01. ***p<0.001.
Abbreviations: SIAS, Social Interaction Anxiety Scale; SAI, State Anxiety Inventory; TAI, Trait Anxiety Inventory; WDQ-SF, Worry Domains Questionnaire Short Form; NEO-PI-N, Neuroticism subscale of NEO-PI; ASQ-I, Insecure subscale of Attachment Style Questionnaire.

Results of Criteria-Related Validity

The correlations between SIAS-17/SIAS-10/SIAS-6P/SIAS-6F/SIAS-5 and criteria scales were significant (r: 0.42–0.56, ps<0.001, see Table 5). For each criterion variable, the results of further difference test in correlations between each SIAS short form and the SIAS-17 were presented in Table 5. The correlation coefficients of the SIAS-10/SIAS-6P/SIAS-6F/ SIAS-5 with SAI were comparable to the SIAS-17 (ps>0.05). The differences in correlation with TAI between SIAS-17 and SIAS-10/SIAS-6P/SIAS-5 were insignificant (ps>0.05), whereas the coefficient of the SIAS-6F was significantly smaller than that of the SIAS-17 (Z=2.20, p<0.05). As to the correlation with WDQ-SF/NEO-PI-N/ASQ-I, except for the SIAS-10 insignificantly differing from the SIAS-17 (ps>0.05), the SIAS-6P/SIAS-6F/SIAS-5 all had significantly weaker correlations than the SIAS-17 (Z: 2.33–5.37, ps<0.05).

Results of Psychometric Properties at Item Level

The discrimination and threshold parameters are shown in Figure 1, in which the items were sorted by the magnitude of discrimination parameters. Of the 17 items, one item (item 13) manifested moderate discrimination parameter (a=1.27), seven items (item 1, 3, 4, 6, 10, 18, 20) had high discrimination parameter (a: 1.41–1.62), and the rest nine items (item 2, 7, 8, 12, 14, 15, 16, 17, 19) had very high discrimination parameter (a: 1.75–2.54). As illustrated in Figure 1, the SIAS-10 included eight items with very high discrimination, the SIAS-6P included two, the SIAS-6F included three, and the SIAS-5 included four. Also, the threshold parameters of the SIAS-17 exhibited a wide range (−2.64–3.92), as shown in Figure 1.

The results of ICCs and OCCs were consistent with the discrimination parameters, those nine items (item 2, 7, 8, 12, 14, 15, 16, 17, 19) with very high discrimination were designated as more informative (see Figure 2), and the rest eight items (item 1, 3, 4, 6, 10, 13, 18, 20) as less informative (see Figure 3). Notably, a total of eight more informative items were included in the SIAS-10, two in the SIAS-6P, three in the SIAS-6F, and four in the SIAS-5, respectively.

Discussion

The SIAS is one of the most prevalent instruments to measure the severity of social anxiety. Over the past decade, four short forms of the SIAS (SIAS-10, SIAS-6P, SIAS-6F, and SIAS-5) have been developed. Both at scale and item levels, the present study comprehensively evaluated and compared the psychometric properties of the four forms with a Chinese undergraduate sample, and ultimately clarified which short form was relatively superior. In this study, the Chinese versions of the SIAS-10, SIAS-6P and SIAS-6F all manifested good structural validity, internal consistency reliability, and criteria-related validity, whereas the SIAS-5 failed to exhibit tenable one-factor structure. Additionally, only the SIAS-10 achieved strict measurement equivalence across gender, while the measurement inequivalence of the SIAS-6P/ SIAS-6F urged researchers' caution to interpret gender differences drawn from them. At last, the superiority of the SIAS-10 was further evidenced by the IRT results, which showed that most of the SIAS-10 items had higher discrimination and

item	SIAS-10	SIAS-6P	SIAS-6F	SIAS-5	a	b1	b2	b3	b4
13					1.27	−1.68	−0.33	0.61	2.16
20					1.41	−1.67	0.01	1.02	2.54
1					1.46	−1.58	−0.13	0.89	2.28
6					1.48	−1.97	−0.73	0.27	2.12
4					1.56	−1.52	−0.12	0.94	2.26
10					1.60	−1.89	−0.20	0.75	2.29
18					1.61	−1.84	−0.30	0.86	2.78
3					1.62	−1.79	−0.29	0.79	2.35
12					1.75	−2.21	−0.70	0.36	2.22
14					1.82	−1.95	−0.06	1.09	3.19
17					1.95	−2.29	−0.70	0.47	2.52
2					2.00	−1.41	0.39	1.81	3.86
8					2.12	−1.75	0.42	1.92	3.78
15					2.16	−1.67	0.17	1.29	2.89
7					2.27	−2.64	−0.96	0.29	2.51
19					2.34	−2.44	−0.69	0.42	2.60
16					2.54	−2.48	−0.19	1.67	3.92

Figure 1 Discrimination parameters and threshold parameters of items in SIAS-17.
Abbreviations: SIAS, Social Interaction Anxiety Scale; a, discrimination parameter; b_k, threshold parameter between Option k and Option k-1 (k=1~4).

were more informative. In general, compared with the SIAS-6P, SIAS-6F and SIAS-5, the SIAS-10 was recommended to be selected after taking psychometric performance at both scale and item levels into account.

In previous studies, the one-factor model of the SIAS was well validated,[13,21–23] and all its short forms were demonstrated as unidimensional.[25–27,34] Consistent with previous results, our results supported the unidimensionality of the SIAS-10, SIAS-6P, and SIAS-6F. Meanwhile, good internal consistency and significant correlations with the criteria measures also provided evidences for their efficiency in assessing social interaction anxiety. To be noticed, although the SIAS-5 exhibited good internal consistency and criteria-related validity, its poor performance in our CFA analysis challenged its tenability of one-factor structure. In addition, this study found that the SIAS-10 was the only short form that correlated with the criteria measures as strongly as the full version, which supported its strength in reflecting mental facets related to social interaction anxiety.

Several previous studies have concerned the measurement equivalence of the SIAS, most of which have focused on the influence of sociocultural contexts,[19] ethics,[65] and clinical diagnoses.[66] However, evidences about the measurement equivalence of the SIAS across gender was limited. As far as we know, the only study concerning the measurement equivalence of the SIAS across gender just included the SIAS-5 and examined its equivalence on factor loadings.[25] Thus, it was indefensible that some previous studies adopted the full SIAS version or its short forms to compare the gender differences in social interaction anxiety and reported that females had more severe social anxiety than males.[27,67] Therefore, in this study, we focused on the measurement equivalence across gender of the SIAS-10/SIAS-6P/SIAS-6F at the configural, weak, strong, and strict level. Our results showed that the configural measurement equivalence of the SIAS-6P was established, which indicated that SIAS-6P assessed social interaction anxiety with one-factor model in both
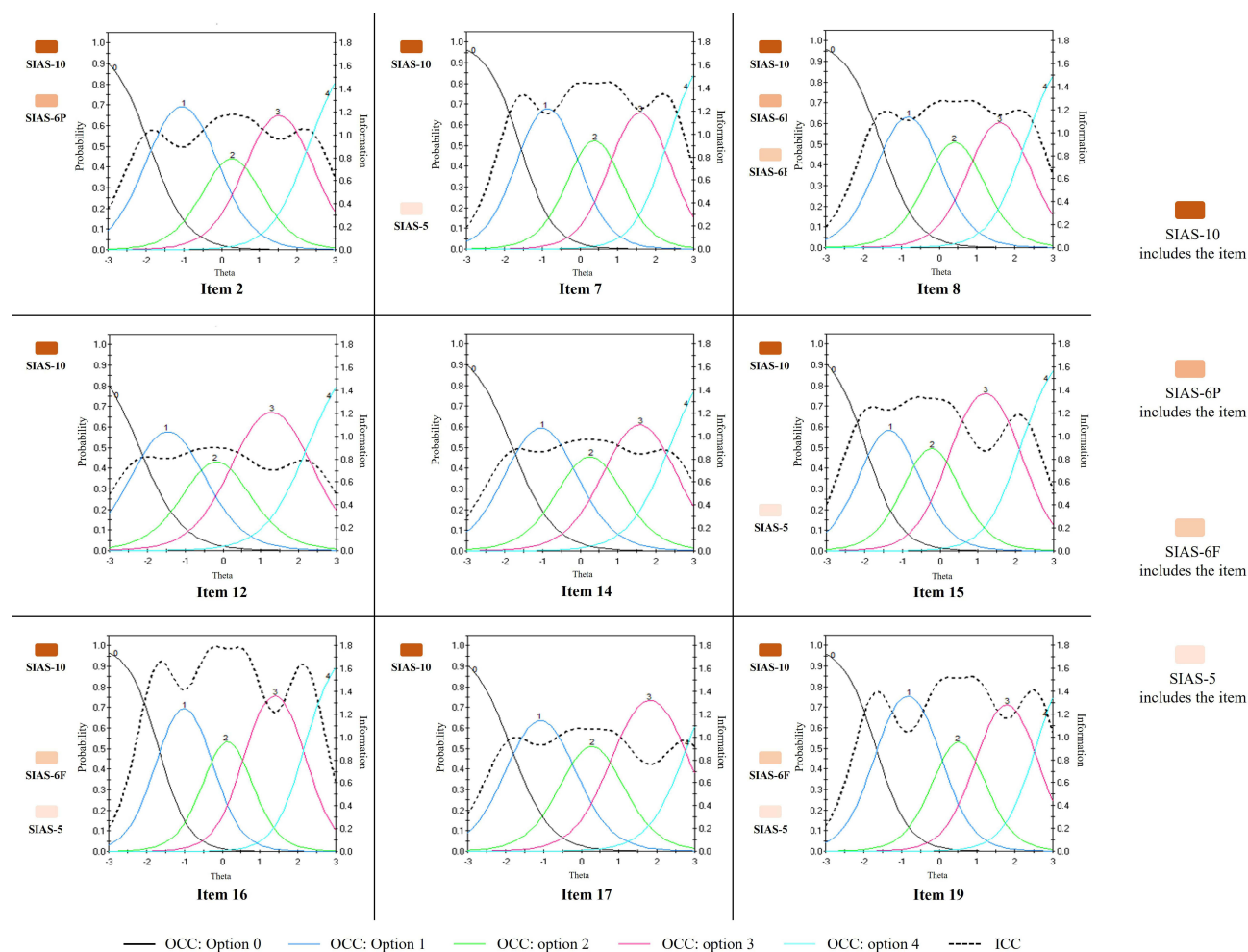
Figure 2 Options characteristic curves and item characteristics curves for more informative items in SIAS-17.
Abbreviations: SIAS, Social Interaction Anxiety Scale; OCC, Option Characteristic Curve; ICC, Item Characteristic Curve.

male and female groups. Meanwhile, the SIAS-6F achieved weak measurement equivalence across gender, which additionally indicated the SIAS-6F reflected the latent social interaction anxiety equivalently for males and females. Furthermore, the SIAS-10 was measurement equivalent strictly across gender in this study, which indicated that it assessed the social interaction anxiety with identical unit, reference point, even measurement error between different gender groups. It was generally thought that the raw scores could be reasonably used to assess the gender differences when the strong equivalence was established. Thus, we suggested researchers to adopt the SIAS-10 to explore the gender differences in social interaction anxiety and keep cautious about the gender differences captured by the SIAS-6P and SIAS-6F due to the contributions from unidentical loadings and intercepts.

In a word, the aforementioned psychometric characteristics of the four short forms of the SIAS help researchers select short form at the whole scale level. Using the IRT method to analyze the component items' characteristics, we then evaluated and compared the measurement properties of the SIAS short forms at item level. Our results showed that the SIAS-10 was mainly composed of items with very high discrimination and more information. In other words, the SIAS-10 could sensitively measure the variation in the underlying trait of social interaction anxiety. This capability was naturally possessed by the SIAS-5 since most of its items (80 percent) were designated as more informative. The SIAS-6F lacked this advantage since it included three items with relatively lower discrimination and less information. For the SIAS-6P, the majority of its items were less informative, which suggested its inferiority in responding to individuals variously located in the continuum of social interaction anxiety. Notably, previous IRT studies focusing on the SIAS-6P did not point out this poor performance, which might be due to the fact that their IRT analyses were executed for the
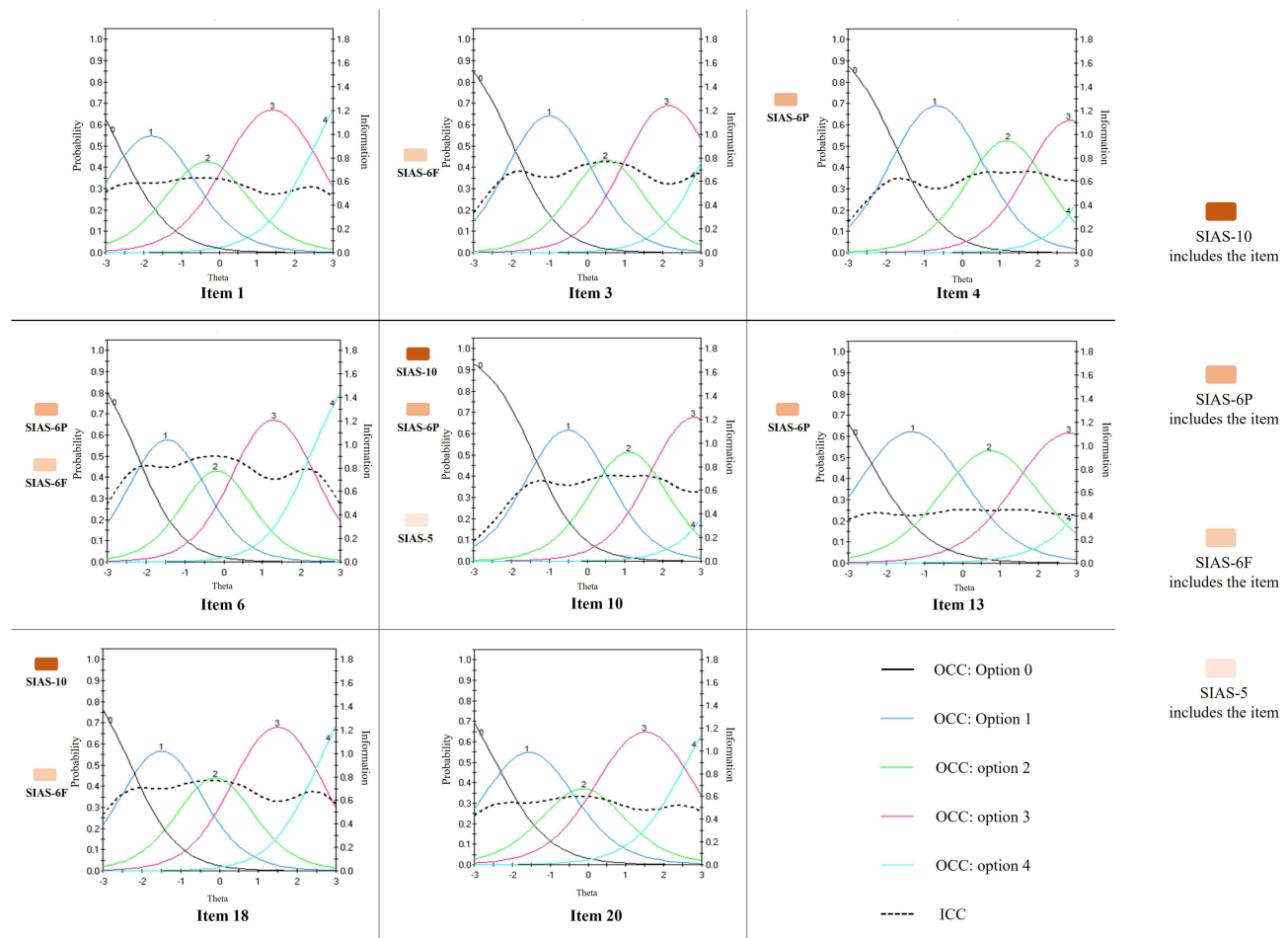
Figure 3 Options characteristic curves and item characteristics curves for less informative items in SIAS-17.
Abbreviations: SIAS, Social Interaction Anxiety Scale; OCC, Option Characteristic Curve; ICC, Item Characteristic Curve.

SIAS-6P alone and neglected other versions.[20,38] Nonetheless, consistent with previous studies, item 13 (ie, *I find it difficult to disagree with another's point of view*) displayed inefficient to detect the variance in social interaction anxiety, with the lowest discrimination and obviously flat and low ICC in our study. Actually, the SIAS-6P was the only short form including item 13. Overall, our IRT results suggested that the SIAS-10 might be the better choice in constrained contexts.

There are several limitations that should be acknowledged. First, the sample employed in our study just comprised Chinese undergraduate students, which made it difficult to generalize the findings to other populations. Subsequent research is warranted to involve a larger and more diverse group of participants, particularly clinical patients who meet the diagnosis criteria of social anxiety disorder. Second, the sensitivity of the short forms of the SIAS to diagnosis and treatment was not examined in this study, while which is crucial for its clinical utility and requires further investigation. Third, due to its cross-sectional design, our research did not assess internal consistency reliability through test–retest measurements, nor did we examine the measurement equivalence across time. Future research should incorporate longitudinal studies to track responses on the SIAS short forms at different time point.

Conclusion

To sum up, the present study offers guidance for clinicians and researchers in selecting a relatively superior short form of the SIAS for Chinese population. Overall, the SIAS-10, SIAS-6P, and SIAS-6F all showed good structural validity, internal consistency reliability, and criteria-related validity among Chinese college students. Notably, the unidimensionality of the SIAS-5 was not supported in our study. The SIAS-10 achieved strict equivalence across gender, whereas the

SIAS-6P and SIAS-6F just achieved configural and weak equivalence, respectively. Furthermore, based on the IRT results, the SIAS-10 demonstrated strength in discriminating various levels of the latent trait of social anxiety. However, more caution should be taken to the application of the SIAS-6P, as its items exhibited bad discrimination. In general, the SIAS-10 is recommended in Chinese, especially considering its ability to measure social anxiety equivalently across gender, its comparable capacity to reflect the relevant criteria variables, and its sensitivity in discriminating individuals with various levels of social anxiety.

Data Sharing Statement

The datasets of this study are available from the corresponding author. Due to privacy or ethical restrictions, the datasets cannot be made public.

Ethics Approval and Informed Consent

This research was approved by the Medical Ethics Committee of the Second Xiangya Hospital, Central South University. The procedures performed were in accordance with the Declaration of Helsinki. All the subjects participated voluntarily and signed the informed consent at enrollment.

Disclosure

All authors declare no conflict of interest.

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