Psychometric Evaluation of the Bangla Communication Scale Among Adolescents:Latent structure, reliability, validity, and gender invariance in a Bangladeshi adolescent sample

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The authors made the following contributions. Nusrat Jahan: Conceptualization, Project Management, Data Curation, Writing - Original Draft Preparation; Mushfiqul Anwar Siraji: Conceptualization, Project Management, Formal Analysis & Data Visualization, Writing - Original Draft Preparation; Review & Editing; Zinnatul Borak: Conceptualization, Writing - Review & Editing.

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Abstract

One or two sentences providing a **basic introduction** to the field, comprehensible to a scientist in any discipline.

Two to three sentences of **more detailed background**, comprehensible to scientists in related disciplines.

One sentence clearly stating the **general problem** being addressed by this particular study.

One sentence summarizing the main result (with the words "**here we show**" or their equivalent).

Two or three sentences explaining what the **main result** reveals in direct comparison to what was thought to be the case previously, or how the main result adds to previous knowledge.

One or two sentences to put the results into a more **general context**.

Two or three sentences to provide a **broader perspective**, readily comprehensible to a scientist in any discipline.

Keywords: keywords

Word count: X

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Communication is a complex behaviour of exchanging information among individuals (Tanner, 2006). Communication plays a central role among adolescents in developing self-identity, social relationships and creates the foundation of collective social activity (Conti-Ramsden & Botting, 2008; Haslett & Bowen, 1989; Spencer, Clegg, & Stackhouse, 2013). Inadequate communication skill may cause poor peer relationship resulting long-term socio-emotional difficulties including social anxiety, stress, low self-esteem and poor academic performance (Brinton & Fujiki, 2004; Reed & Trumbo, 2020).

Often adults picture adolescents having inadequate and inept communication skills (Stern, 2005; Thurlow, 2003). Media representation of adolescents often includes “storm-and stress,” self absorbed and disengaged type behaviours (Porteous & Colston, 1980; Stern, 2005). As such adolescents are often labelled as “lazy” and “disrespectful” by the adults (Agenda & America, 1999). On the contrary adolescents are highly engaged in work, community services and extracurricular activities and also more aspiring to earn an college degrees (DeBard, 2004; Schneider & Stevenson, 1999). Such a discrepancy between the reality of adolescent’s image and adult’s perception of the adolescents might be attributed to the mismatch of communication skills. The communication pattern of adolescents might not necessarily same as the adults. In addition to face to face communication, adolescents are vastly exposed to different virtual communication platforms. This may cause them to face more complex social challenges than the adults (Thurlow, 2003). “Communication capital” expresses the potential of civic-engagement that incorporates developing social relationships and influences collective social activity. The more communication capital an individual has the easier the instances of civic engagement become.

Understanding the adolescents' communication skill vital as it is considered as the "key skill" in the education (Thurlow, 2001) and employment market (Olszewski, Panorska, & Gillam, 2017). In the western society, adolescents are now facing high unemployment (Lindsay et al., 2014). Lack of adequate communication skill is one of the root causes of this high unemployment (Lindsay et al., 2014). Similarly, lack of proper communication skill often promotes the propensity of anti-social behaviours and risk of exclusion from schools (Clegg, Stackhouse, Finch, Murphy, & Nicholls, 2009; Conti-Ramsden & Botting, 2004).

To promote better understanding of subject contents assessing the communication skill among adolescents is highly required. For this purpose "Communication Skill" sub-skill set (Barkman & Machtmes, 2002) was developed in 2002 as a part of The National On-line Youth Life Skills Evaluation System (Mincemoyer, Perkins, & Munyua, 2005) and since then it has been extensively used (Fitzpatrick, Gagne, Jones, Lobley, & Phelps, 2005).

Study-1: Translations and Exploratory Factor Analysis

Study-1 had two objectives. First we translated the 23 items of the Communication Scale (Barkman & Machtmes, 2002) from English to Bangla. Second, we conducted an Exploratory Factor Analysis (EFA) to identify the latent structure of the scale.

Methods

Participants. A cross-sectional survey was used to collect data from a large sample of students of grade 8-12 (n = 300) from 8 schools following convenience sampling method.One participant was excluded due to incomplete data. Participants were recruited following convenience sampling technique. For exploring the initial factor structure the recommended sample size is 250-300 (Comrey & Lee, 1992; Schönbrodt &

Perugini, 2013). Among 300 participants, 218 were female aged between 12 to 21 years (15.89±1.46). 82 were male with an age range between 13 participants 23 years (16.62±1.38). 282 (94%) participants belonged to middle socio-economic status. 13 (4.3%) and 5 (1.7%) participants belonged to lower and upper socio-economic status-respectively.

Materials.

Communication Scale.

Communication Scale (Barkman & Machtmes, 2002) is a sub-skill set of The National On-line Youth Life Skills Evaluation System (Mincemoyer et al., 2005). It has 23 items with a 5 Point Likert Type response scale (0=Never, 1=Rarely, 2=Sometimes, 3=Often, 4=Always). The total score range is 0-92 where a higher score would indicate higher communication skills among adolescents (age range 12-18). The internal consistency of the total scale, Cronbach α was .79

Bangla Communication Scale.

We followed the International Test Commission guidelines (Bartram et al., 2018) while translating the Communication Scale in Bangla. At first two bilingual researchers did the forward translation. These two forward translations were synthesized by the authors. Another four bilingual researchers did the backward translation of the synthesized Bangla Communication Scale. The authors again synthesized the back-translations, compared it with original scale and made necessary amendments.

Data collection. The project received institutional ethics clearance from Department of Educational and Counselling Psychology (Project ID: —). Prior to data collection necessary authorization from school's authority and assent from the participating were obtained. Necessary explanations were given in oral and written forms.It was also mentioned in the explanatory statement that their participation was voluntary and that they could withdraw from participation any time without being

penalized. Data collection was commenced between November 2021 to January 2022. The data collection took place in the classroom where students were at first briefed about ‘communication skill.’ Next. they filled up their socio-demographics information and responded to our Bangla Communication Scale. All personal information (name, school,class) was codified and encrypted, producing a anonymous database.

Analytic strategies. We used R (version 4.1.0) (R Core Team, 2021), including several R packages (Chalmers, 2012; Revelle, 2021; Rosseel, 2012; Siraji, 2021), for our analyses. Prior to the data analysis normality assumptions were checked. Our data violeted both univariate and multivariate normality. As such we used polychoric correlation matrix and ’principal axis” factor extraction method to conduct the exploratory factor analysis (Watkins, 2020). An oblique rotation method was employed. A posterior sampling adequacy was estimated using KMO statistics (Kaiser, 1974). TO identify the optimum number of factors required to explain the latent structure of our scale we used Scree plot (Cattell, 1966), Horn’s parallel analysis (Horn, 1965), Hull method (Lorenzo-Seva, Timmerman, & Kiers, 2011) and Minimum average partials method (MAP) (Velicer, 1976). Lastly, to identify the simple structure, we followed the following guidelines (i) no factors with fewer than three items (ii) no factors with a factor loading <0.3 (iii) no items with cross-loading greater than .3 across factors (Child, 2006; Mulaik, 2009; Watkins, 2020)

Results & Discussion.

Sampling adequacy.

Kaiser-Meyer-Olkin (KMO) (Kaiser, 1974) statistics was used to check the sampling adequacy. The overall KMO value for 23 items was 0.74, which was above the cut-off value of .50, indicating an adequate sample.

Descriptive statistics and item analysis.

Table1 reports univariate descriptive statistics for the 23 items. All items were

skewed and violeted univariate normality assessed by The Shapiro-Wilk test indicated all the items violated normality assumptions (Shapiro & Wilk, 1965). Mardia's Test of multivariate normality (Mardia, 1970) yielded Multivariate skew = 4030.49 (p <0.001) and multivariate kurtosis = 15.1 (p <0.001) indicating the violation of multivariate normality as well. As such we used polychoric correlation matrix which is more robust towards these violations. Our initial item analysis yelled internal consistency coefficient ordinal alpha = 0.79. Alpha drop statistics (Table1) showed no substantial increase of ordinal alpha if any item is deleted and ranged between 0.8-0.8. As such we subjected all items to EFA.

Supplementary Table 1 and Figure 1 depict the inter-item correlation coefficients of BCS. Bartlett's test of sphericity (Bartlett, 1954), χ^2 (253) = `rbartlet$chisq`, p < .001 indicated the inter-item correlations are significantly different than zero. However, only 9.88% of the inter-item correlation coefficients were greater than absolute value of .30 in the obtained matrix. The corrected item-total correlations range was 0.05- 0.56 (Table1).

####Exploratory factor analysis

To identify opttimum number of factor required to express the latent structure adequetly we at first used Horn's parallel analysis (Horn, 1965). Horn's parallel analysis offered two factor solution to the latent structure (Figure 2). However, The Scree-plot (Cattell, 1966) suggested one factor solution. One factor solution was also supported by MAP method (Velicer, 1976) and Hull method (Lorenzo-Seva et al., 2011). Minimum average partial (MAP) method expects the average squared off-diagonal values of the calculated partial correlation matrix to be minimum when the correct number of factors are extracted (Velicer, 1976). In our data set this value reached the minimum after extracting the first factor (Supplementary Table 2). Hull methop tried to find an optimal number of factors to balance model fit and the number of parameters and offeren one factor solution in our data set (Figure 2). As a result, we tested both one-factor and two-factor solutions.

At first we fitted one factor solution in our dataset with all 23 items. The initial solution had six items with poor factor loadings (Item 1, 2,5,9, 16, 23). We discarded these items from the model and run another EFA. This iteration of EFA yielded a one factor simple structure with 17 items. The one factor solution explained 20.87% of the total variance. Cronbach's alpha coefficient has a tendency to deflate the estimates for Likert type data as the calculation is based on pearson-correlation matrix which requires data with continuous measurement level (Gadermann, Guhn, & Zumbo, 2012; Zumbo, Gadermann, & Zeisser, 2007). For better estimates of reliability we reported ordinal alpha using polychoric-correlation (Zumbo et al., 2007). The internal consistency reliability coefficient for this model was, ordinal α = .81.

The initial two-factor solution with all 23 items had several items (item 01, 03, 05 09, 16) with poor factor loading (<.3) . We conducted another two round of EFA and identified and discarded problematic items (with poor factor loadings and/or cross loadings). Finally, a two-factor EFA solution with 15 items was accepted with RMSR = 0.06, no loading smaller than .30 and no cross-loading greater than .30. The first factor retained 8 items, and the second factor retained 6 items. The first factor explained 15.42% of the total variance and the second factor explained only 10.75. Ordinal alpha coefficient value ranges from 0 to 1 and higher value represents better reliability. The internal consistency reliability coefficient for the two factors were, ordinal α = .75 and .66 respectively. Items clustered under factor 1 were stemmed from several common theme including efficiency of verbal communication, individual's efficiency in verbal communication. All items except item12 (I try to see the other person's point of view) investigated individual's efficiency in non-verbal communication. The average variance extracted (AVE) is the amount of joint variance captured by the components and not by measurement error. Fornell and Larcker (1981) recommended .50 as a benchmark value of AVE to establish the converging validity and purity of particular factor. AVE for these two factors were.25 and .23 indicating high measurement error. Due to such high

measurement error of the factor we rejected the two factor model and accepted the one factor model which had satisfactory reliability

Measurement Invariance

To gather more information on our retained one-factor solution, we sought Item Response Theory (IRT). IRT complements the conventional classical test theory-based analysis by gathering information on item discrimination and item difficulty. IRT judges an item's quality by providing item information in the light of participants' trait level (θ). We gathered evidence on item quality as well as item fit, person fit and model by fitting a graded response model in RStudio with the "mirt" package (Chalmers, 2012) (Chalmers, 2012). We did a Monte Carlo simulation using "SimDesign" package (Chalmers & Adkins, 2020) with sample sizes varying from 50-350 and calculated average root mean squared error(RMSE) to estimate the optimal sample size for the graded response model with 23 items. The RMSE became stable for n = 200 to 300 (RMSE ranging between .25-.35). Our sample size within the estimated sample size for stability.

Marginal reliability is based on the true score model (Lord & Novick, 1968) and is an estimate of the overall reliability of a test based on the average conditional standard errors. Often it is close in value to coefficient alpha (and sometimes it may even be identical). Alpha provides a lower estimate of marginal reliability.

Results

Discussion

Ethical Consideration

All procedures performed in studies involving human participants were in accordance with the 1964 Helsinki declaration and its later amendments or comparable

ethical standards. This article does not contain any studies with animals performed by any of the authors.

Data and code availability

All code and data underlying this article is available on a public GitHub repository (https://github.com/masiraji/Communication).

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Table 1

Items	Mean	SD	Skew	Kurtosis	Shapiro-Wilk Statistics	Item-Total Correlation	Alpha Dro
CS01	2.97	1.02	-0.65	-0.43	0.84*	0.20	0.79
RCS02	2.51	1.18	-0.26	-0.96	0.89*	0.26	0.79
CS03	2.94	1.09	-0.72	-0.44	0.84*	0.35	0.78
CS04	2.47	1.23	-0.42	-0.79	0.89*	0.33	0.79
RCS05	2.50	1.31	-0.48	-0.87	0.87*	0.08	0.80
CS06	2.82	0.97	-0.62	-0.01	0.87*	0.40	0.78
CS07	2.70	1.16	-0.63	-0.59	0.86*	0.41	0.78
CS08	2.92	1.07	-0.87	0.00	0.84*	0.36	0.78
CS09	3.60	0.76	-2.24	4.73	0.56*	0.18	0.79
CS10	3.08	0.97	-0.81	-0.18	0.82*	0.34	0.78
CS11	3.17	1.00	-1.07	0.40	0.78*	0.52	0.77
CS12	2.58	1.19	-0.40	-0.83	0.89*	0.43	0.78
CS13	3.22	1.12	-1.35	0.81	0.72*	0.29	0.79
CS14	2.82	1.10	-0.79	-0.06	0.86*	0.43	0.78
CS15	3.34	0.82	-1.19	1.19	0.76*	0.51	0.77
CS16	2.63	1.26	-0.45	-1.00	0.87*	0.28	0.79
CS17	2.20	1.33	-0.04	-1.22	0.89*	0.36	0.78
CS18	2.86	1.07	-0.76	-0.11	0.85*	0.38	0.78
CS19	2.03	1.23	-0.08	-0.93	0.91*	0.44	0.78
CS20	2.73	1.00	-0.44	-0.47	0.88*	0.52	0.78
CS21	2.79	1.08	-0.66	-0.25	0.87*	0.56	0.77
CS22	3.00	1.06	-0.94	0.26	0.82*	0.44	0.78
CS23	2.31	1.22	-0.12	-0.91	0.90*	0.05	0.80

Table 2

Factor loadings of two factor model

item	PA1	PA2	Communality	Uniqueness
CS15	0.71		0.494	0.506
CS22	0.65		0.319	0.681
CS20	0.53		0.333	0.667
CS11	0.5		0.368	0.632
CS18	0.48		0.195	0.805
CS14	0.45		0.248	0.752
CS13	0.42		0.163	0.837
CS06	0.34		0.166	0.834
CS10	0.32		0.115	0.885
CS19		0.64	0.372	0.628
CS04		0.61	0.302	0.698
CS17		0.51	0.231	0.769
CS12		0.47	0.25	0.75
CS08		0.39	0.171	0.829
CS07		0.35	0.198	0.802
% of Variance	0.15	0.11		

Table 3

Measurment Invariance analysis on CFA sample (n=262) across native and non-native English speakers.

	Chi-Square	df	CFI	TLI	RMSEA	RMSEA 90% Lower CI	RMSEA 90% Upper	Chi-Square Difference	df difference*	p	NA
Configural	245.13	238.00	0.99	0.99	0.01	0.00	0.04	0.08	-	-	-
Metric	280.35	254.00	0.98	0.97	0.03	0.00	0.04	0.08	13.481a	16	0.637
Scalar	290.78	270.00	0.98	0.98	0.02	0.00	0.04	0.08	13.002b	16	0.673
Residual	303.44	287.00	0.98	0.98	0.02	0.00	0.04	0.09	14.008c	17	0.667

Note. a = Metric vs Configural; b = Scalar vs Metric; c = Residual vs Scalar; * = df of model comparison

Table 4

Items discrimination and response category difficulty thresholds of 17 items in Bangla Communication

Items	a	b1	b2	b3	b4	Standardized Outfit	Standardized Infit	S-Chi-square
CS03	0.67	-5.51	-3.25	-1.18	0.69	-0.73	-0.59	80.74
CS04	0.92	-2.92	-1.46	-0.15	1.61	-1.34	-1.09	86.36
CS06	0.72	-5.36	-3.25	-1.09	1.50	-0.50	-0.61	101.14
CS07	0.90	-3.83	-2.04	-0.76	1.16	-1.18	-0.95	77.50
CS08	0.88	-4.44	-2.63	-1.19	0.75	-1.10	-0.82	71.65
CS10	0.64	-6.98	-3.98	-1.57	0.84	-0.62	-0.50	89.19
CS11	1.22	-4.06	-2.83	-1.40	-0.10	-1.18	-0.87	60.34
CS12	0.82	-3.82	-1.97	-0.34	1.23	-0.80	-0.91	76.70
CS13	0.75	-4.81	-3.17	-1.89	-0.29	-0.75	-0.53	76.21
CS14	0.75	-4.88	-2.93	-0.99	1.34	-0.96	-0.80	64.03
CS15	1.16	-4.00	-3.30	-1.70	-0.09	-1.10	-0.77	64.76
CS17	0.89	-2.74	-0.94	0.43	1.78	-1.14	-1.26	75.92
CS18	0.71	-5.54	-2.98	-1.37	1.02	-0.61	-0.61	92.33
CS19	1.01	-2.11	-0.92	0.60	2.31	-0.87	-1.13	96.62
CS20	1.15	-4.16	-2.10	-0.60	1.22	-1.56	-1.49	69.01
CS21	1.20	-3.46	-2.08	-0.73	0.91	-1.67	-1.39	56.50
CS22	0.66	-5.71	-3.67	-1.66	0.68	-0.79	-0.53	70.85

Note. a = item discrimination parameter; b(1-4) = response category difficulty parameter

Table 5

Correlation matrix of the main variables

	1	2	3	4	5
1 Communication					
2 F1	.83**				
3 F2	.83**	.45**			
4 Hopelessness	-.16*	-.11	-.15+		
5 Life Satisfaction	-.02	-.02	.00	.02	
6 SE	.04	.02	.01	-.58**	-.07

Note. **p < .001

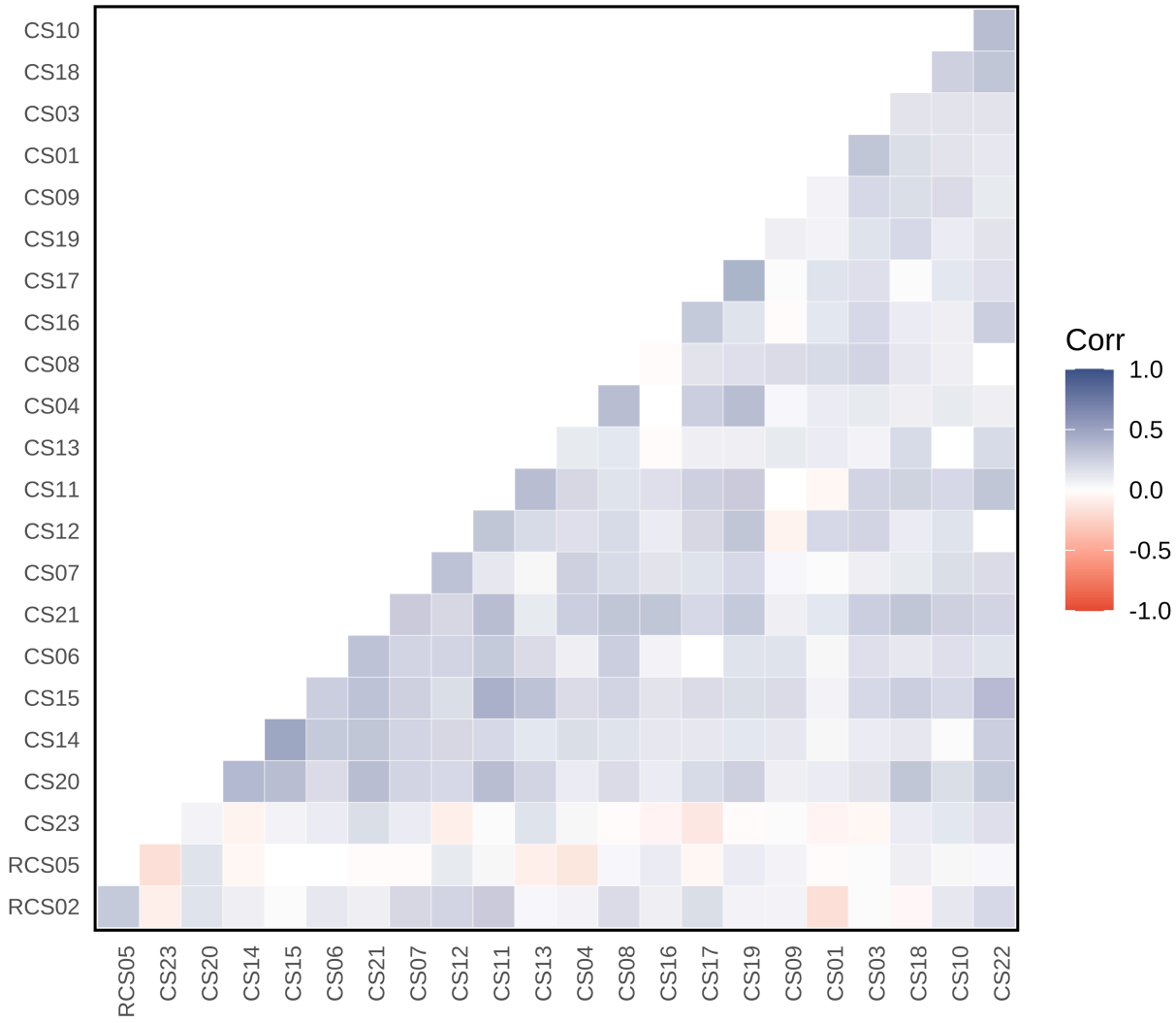

Figure 1. Inter item polychoric correlation coefficients for the 23 items. 9.8 % inter-item correlation coefficients were higher than |.30|

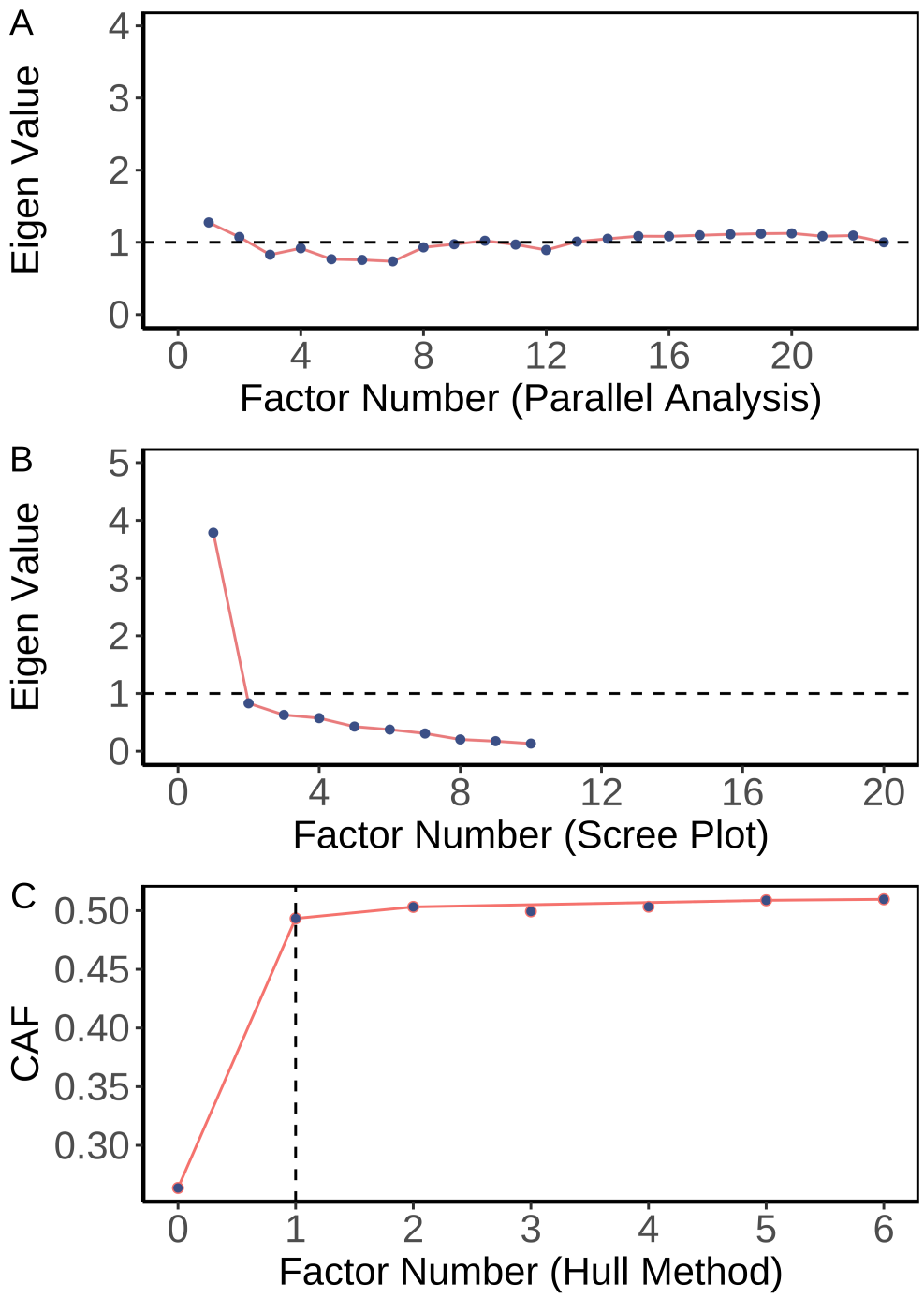

Figure 2. Factor Identification Methods (A) Parallel analysis indicated the optimal number of factors were two. (B) Scree plot suggested one factor. (C) Hull method indicated one factor were required to balance the model fit and number of parameters.

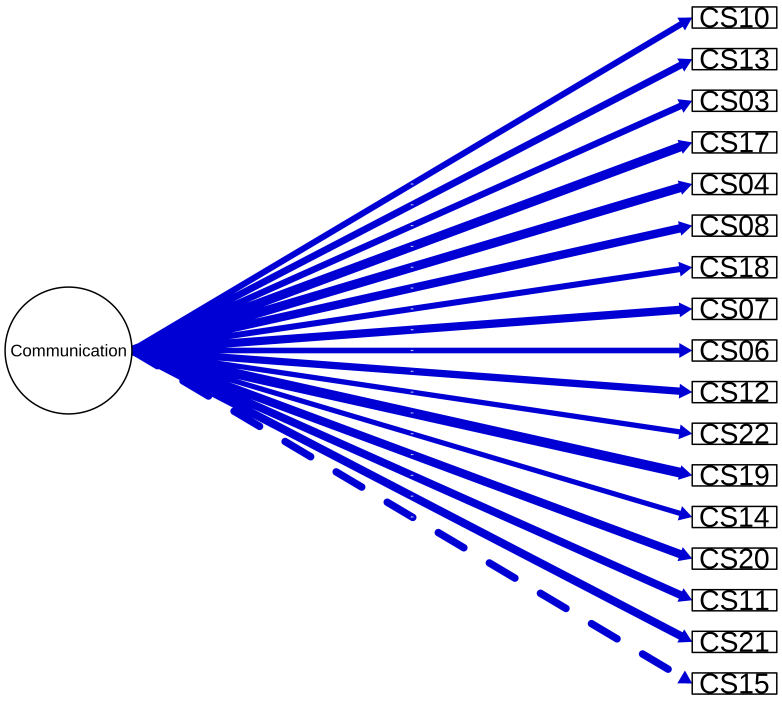

Figure 3. CFA Plot.

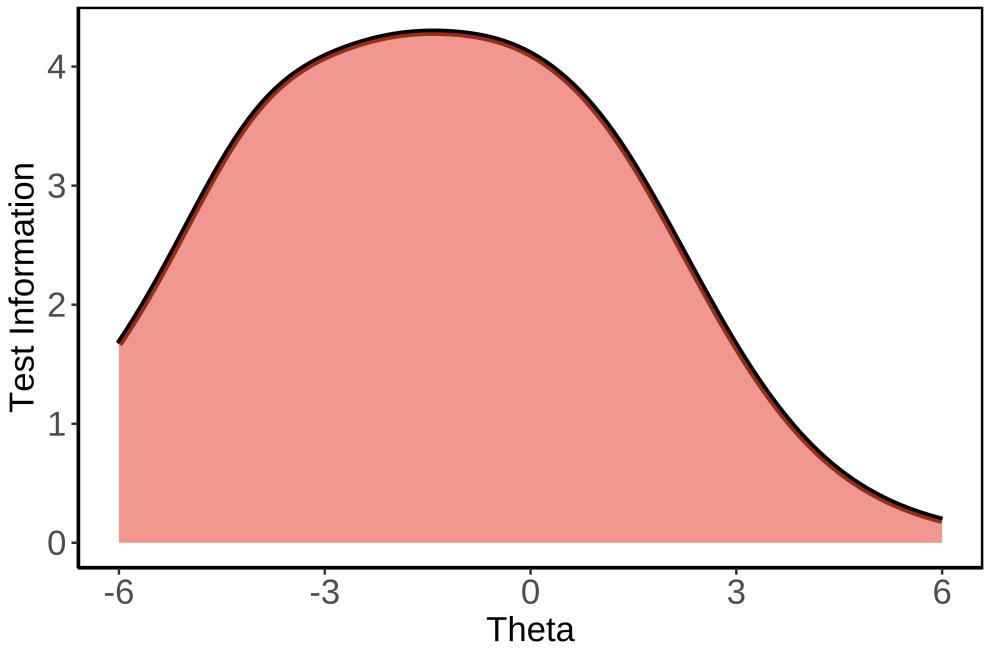

Figure 4. TIC.

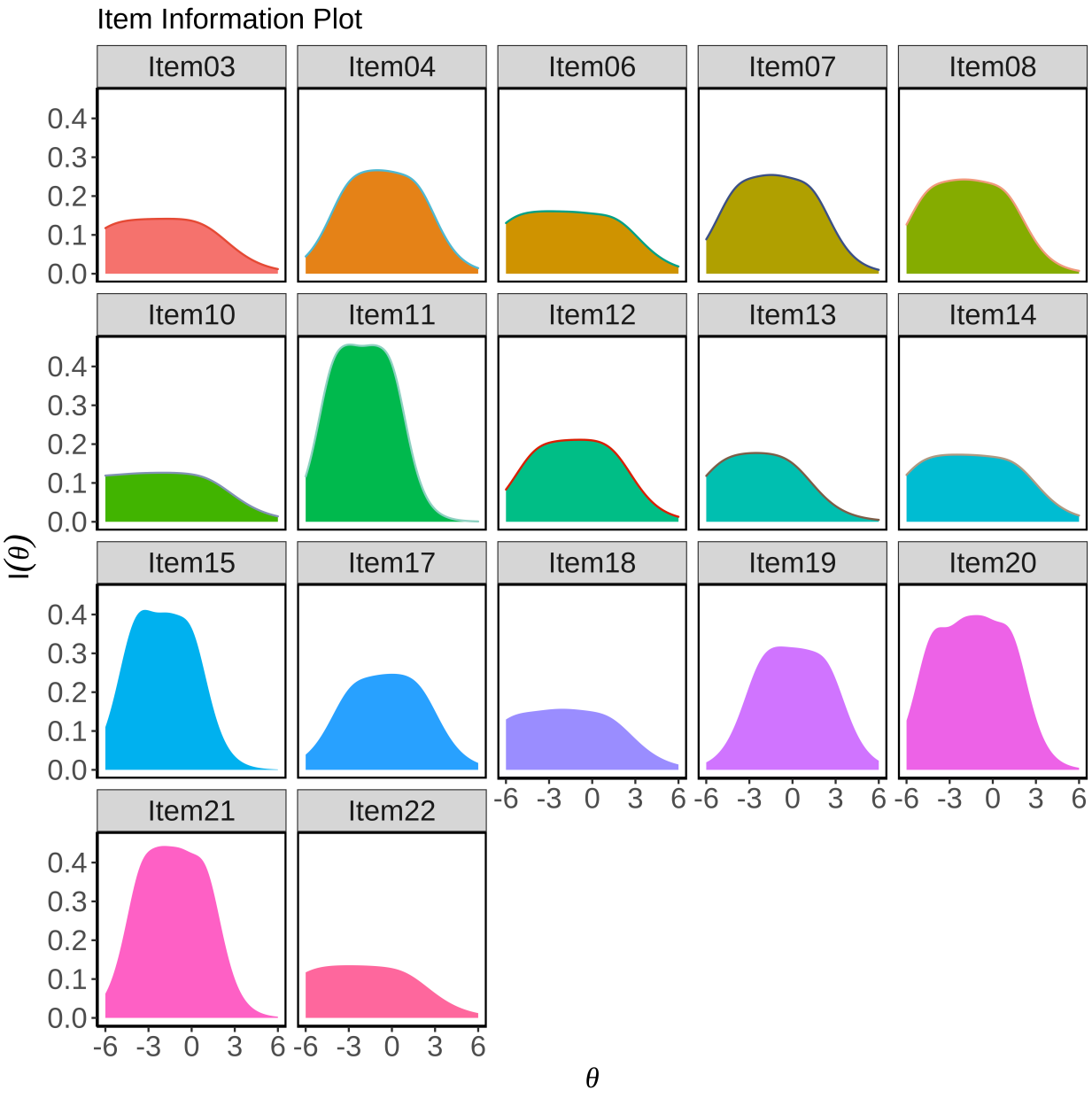

Figure 5. Item Information Curve.

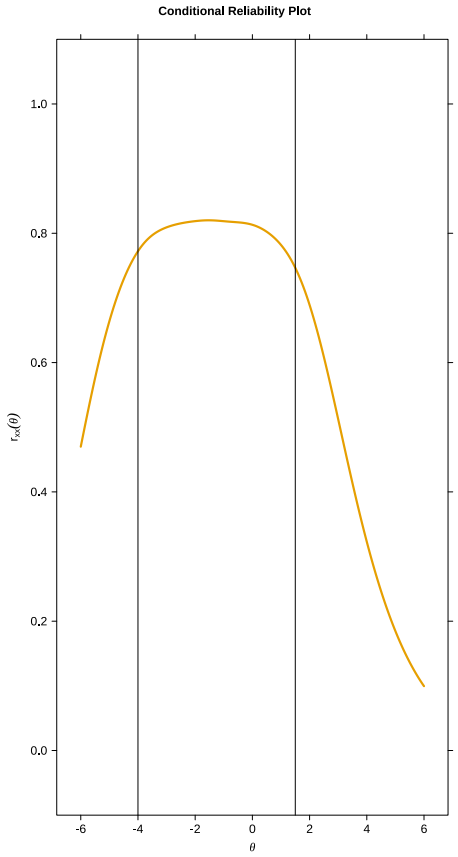

Figure 6. Conditional Reliability.