

ORIGINAL ARTICLE

An Examination of Measurement Invariance of the Brief Suicide Cognitions Scale

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ABSTRACT

Background: The Brief Suicide Cognitions Scale (B-SCS) is a self-report measure of suicidogenic cognitions. This study evaluated measurement invariance of the B-SCS among different subgroups. Secondly, this study sought to evaluate the replicability of the psychometric validity, reliability, and factor structure of the B-SCS.

Methods: Participants included undergraduate students ($N = 2000$) recruited between 2022 and 2023. Multigroup Confirmatory Factor Analyses (CFA) were conducted comparing participants by race, ethnicity, gender, and sexuality.

Results: Results support the existence of a unidimensional factor structure of the B-SCS. Multigroup CFA analyses yielded all levels of measurement invariance across White and Black, Hispanic and Non-Hispanic, cisgender men and women, and heterosexual and sexual minority individuals. Additionally, the B-SCS was found to have strong internal consistency and good concurrent validity. Finally, the B-SCS was able to discriminate between participants who had a history of suicide attempts and those who did not.

Conclusion: These results indicate that the B-SCS is a valid and reliable tool to be used in assessing suicidogenic cognitions. Moreover, results from measurement invariance analyses indicate that this tool may be viable to use within specific sub-populations examined within this study.

1 | Introduction

In 2022, one person died by suicide every 10.6 min (Centers for Disease Control and Prevention [CDC] 2023a, 2023b). Moreover, among those aged 18–25, between 8.8 and 12.3 million considered suicide within the past-year (SAMHSA 2022), and 6216 died by suicide in 2021 (CDC 2023b). While research has identified numerous risk factors associated with suicidal thoughts and behaviors (Ribeiro et al. 2018; Wolfe et al. 2019; Stephenson et al. 2006; Baiden et al. 2022; Shadick et al. 2015), cognitive frameworks of suicide may help explain vulnerabilities that predispose one to risk for suicidal ideation. One such model, the fluid vulnerability theory (Rudd 2006), posits that individuals maintain a baseline level of suicide risk, comprised of enduring

vulnerabilities that predispose one to future risk for suicidal ideation or attempts. Contributing to one's baseline level of risk may be the suicidal belief system (Rudd 2000), which is a cognitive state comprised of core beliefs that predispose one to be at heightened risk for a suicidal crisis. That is, the suicidal belief system represents a trait-like, enduring vulnerability for suicidal ideation. Perceived burdensomeness, unlovability, poor distress tolerance (i.e., unbearability), and hopelessness may be part of this suicidal belief system (Bryan and Rudd 2018). Research has shown these constructs to be moderately correlated (Van Orden et al. 2012; Hill and Pettit 2012), indicating that these beliefs may be interrelated and unified by a common factor—the suicidal belief system (Rudd 2006; Bryan and Rudd 2018; Bryan, May, et al. 2022).

To assess the suicidal belief system, Rudd et al. (2010) developed the Suicide Cognitions Scale (SCS). The SCS has demonstrated the ability to discriminate between suicide attempts and non-suicidal self-injury among military personnel (Bryan et al. 2014) and adults receiving psychiatric inpatient care with and without a history of a suicide attempt (Ellis and Rufino 2015). Subsequent research supported a revised, shorter version of the SCS (SCS-R), which has been psychometrically validated (Bryan, May, et al. 2022; Bryan, Thomsen, et al. 2022) and evidences a unidimensional, general factor structure (Moscardini et al. 2023). Moreover, the SCS-R has been able to discriminate between those with and without suicide attempts (Bryan, Thomsen, et al. 2022; Moscardini et al. 2023). Finally, bifactor models of the SCS-R have demonstrated measurement invariance between adults who self-identify as cisgender men and women, between adults who identify as Black, Asian, First Nations, and White, and between straight/heterosexual, gay/lesbian, and bisexual individuals (Oakey-Frost et al. 2024).

Although shorter than the SCS, there may be limitations regarding the use of the SCS-R in repeated measurement, such as intensive longitudinal research designs. Moreover, given that the SCS and SCS-R are 18 and 16 items, respectively, their use in clinical settings such as inpatient psychiatric units or emergency departments may have limited feasibility. To address these concerns, Rudd and Bryan (2021) developed the Brief Suicide Cognitions Scale (B-SCS). Consisting of the six items with the strongest factor loadings from the subfactors of the SCS (unlovability, unbearability, and unsolvability), the B-SCS provides a tool capable of measuring suicide cognitions in settings where long measures may have limited feasibility (Rudd and Bryan 2021). The B-SCS has been shown to have strong internal consistency ($\alpha = 0.84\text{--}0.91$) across different populations and has been able to differentiate between those with and without a history of suicide attempts (Rudd and Bryan 2021; Arafat et al. 2022; Arslan et al. 2024). Of note, the B-SCS includes one item which explicitly mentions suicide (item 6: "Suicide is the only way to end the pain."); however, within the initial psychometric evaluation, concurrent validity was supported with and without item six included (Rudd and Bryan 2021). Additionally, the B-SCS has consistently been found to have a single, latent factor when evaluated within the United States (Rudd and Bryan 2021), Bangla (Arafat et al. 2022), and Turkish college students (Arslan et al. 2024).

The B-SCS shows promising potential to be a useful tool for briefly assessing suicidogenic cognitions. As not all suicide attempts are preceded by explicit suicidal ideation (Baca-Garcia et al. 2011), the B-SCS provides an alternative method for identifying and monitoring suicide risk across settings. However, as endorsement of suicidal behaviors varies between groups (e.g., by race: Baiden et al. 2022; or by gender: Stephenson et al. 2006), it is important to make direct, group-based comparisons to ensure that the constructs being assessed are similar between groups. Given the potential clinical utility of the B-SCS, ensuring the scale is measurement invariant allows for more generalizable use within diverse populations. To date, no study has assessed the B-SCS for measurement invariance. Thus, the current investigation sought to investigate measurement invariance of the B-SCS across gender, sexuality, race, and ethnicity. It was hypothesized that the study would sufficiently meet configural,

metric, scalar invariance, and residual invariance. Additionally, this study sought to replicate and extend upon previous research evaluating reliability and validity of the B-SCS among college students (Rudd and Bryan 2021). It was hypothesized that the B-SCS would demonstrate concurrent validity with measures of similar constructs (e.g., thwarted belongingness, perceived burdensomeness, suicidal ideation), content validity and internal consistency.

2 | Methodology

2.1 | Participants

Participants were 2000 psychology students recruited from the undergraduate participant pool at Louisiana State University. Recruitment occurred between November 2022 and November 2023. Potential participants were identified and screened via the university SONA research participation system. Eligible participants had to be at least 18 years of age. Interested participants could access a Qualtrics survey link in which they were prompted to review an informed consent document. Upon providing consent, participants completed a series of randomly ordered self-report questionnaires asking about demographics, depression, anxiety, and their experience with suicidal thoughts and behaviors. Upon completion of study procedures, all participants received a debriefing form which included mental health treatment resources. All study procedures were approved by the Louisiana State University Institutional Review Board. Within this sample, participants reported a mean Suicide Ideation Scale (SIS) score of 12.26 ($SD = 5.06$), with 16.6% reporting suicidal ideation within the past-year, and 201 participants endorsing a history of a lifetime suicide attempt. See Table 1 for a complete demographic breakdown of the sample.

2.2 | Measures

2.2.1 | Demographics

Participants were asked a series of demographic items assessing sex, gender, race, ethnicity, and current year in school.

2.2.2 | Suicide Attempt History

Participants were asked, "Have you made a suicide attempt in which you had some intent to die?" Response options included "No (1)", "Yes, within the last month (2)", "Yes, within the last 6 months (3)", "Yes, within the last year (4)", "Yes, more than 1 year ago but less than 5 years ago (5)", and "Yes, 5+ years ago (6)". Response options were collapsed into a binary variable to identify presence ($n = 201$) or absence of ($n = 1638$) a lifetime history of suicide attempt.

2.2.3 | Brief Suicide Cognitions Scale (B-SCS)

The B-SCS (Rudd and Bryan 2021) is a 6-item self-report scale in which items are rated on a 5-point Likert-type scale from 1 ("Strongly Disagree") to 5 ("Strongly Agree"). Table 2 presents

TABLE 1 | Sample sociodemographic characteristics.

Variable	M (SD) or <i>n</i>
Age (Mean, SD)	19.13 (1.88)
Gender identity (<i>n</i>)	
Cisgender woman	1437
Cisgender man	375
Transgender or gender diverse	38
Prefer not to disclose	24
NA/Missing	24
Race (<i>n</i>)	
White	1247
Black/African American	444
Hispanic, Latinx, or Spanish Decent	184
Asian American	133
American Indian/Alaska native	17
Middle Eastern/North African or Arab Origin	20
Native Hawaiian/Pacific Islander	10
Prefer not to say	10
Sexual orientation (<i>n</i>)	
Heterosexual/straight	1510
Bisexual	132
Asexual	90
Gay or Lesbian	53
Pansexual	23
Queer	10
Demisexual	1
No label	2
Questioning	41
Other	2
Prefer not to say	27
NA/Missing	7

Note: The sum of demographic racial identities may exceed the total sample of 1898, as participants were instructed to check “all that apply”.

B-SCS items and item-level response frequencies within the current sample. Psychometric properties of the measure in the current investigation are provided in the results below.

2.2.4 | Interpersonal Needs Questionnaire (INQ)

The Interpersonal Needs Questionnaire (INQ) is a 15-item self-report measure that assesses perceived burdensomeness and thwarted belongingness (Van Orden et al. 2012). With six questions assessing perceived burdensomeness and seven questions

assessing thwarted belongingness, the INQ-15 has demonstrated acceptable psychometric properties of reliability and validity (Van Orden et al. 2012; Feinstein et al. 2022). In this study, strong internal consistency was found for INQ subscales of perceived burdensomeness ($\alpha = 0.94$) and thwarted belongingness ($\alpha = 0.88$).

2.2.5 | Interpersonal Hopelessness Scale (IHS)

The Interpersonal Hopelessness Scale is a 10-item self-report scale that assesses feelings of interpersonal hopelessness central to perceptions that one is a burden on others and hopelessness about feelings of thwarted belongingness (Tucker et al. 2018). Studies evaluating the psychometric properties of the IHS have found strong validity and reliability of the IHS and a two-factor structure when administered among individuals with past week suicidal ideation (Mitchell et al. 2024). In this study, strong internal consistency was found for IHS subscales of perceived burdensomeness ($\alpha = 0.94$) and thwarted belongingness ($\alpha = 0.94$).

2.2.6 | Suicide Ideation Scale (SIS)

The SIS (Rudd 1989) is a 10-item questionnaire that assesses past week suicidal thoughts and behaviors. The SIS has shown adequate reliability and valid assessment of suicidal ideation (Rudd 1989; Luxton et al. 2011). In this study, strong internal consistency was found for the SIS ($\alpha = 0.93$).

2.3 | Analytic Plan

Data analyses were conducted using R (R Core Team 2022), using the lavaan package (Rosseel 2012). All participants who did not complete the B-SCS in its entirety ($n = 102$) were removed. Initial confirmatory factor analysis (CFA) model fit was identified by a comparative fit index (CFI) and/or Tucker-Lewis index (TLI) ≥ 0.95 , standardized root mean square residual (SRMR) ≤ 0.08 (Hu and Bentler 1999), and root mean square error of approximation (RMSEA) ≤ 0.05 indicating optimal model fit, with values between 0.05 and 0.08 identified as acceptable (Browne and Cudeck 1992). Using the identified optimal model, measurement invariance was tested across gender, sexuality, race, and ethnicity at levels of configural (i.e., same factor structure across groups), metric (i.e., equal factor loadings across groups), scalar (i.e., equal item thresholds across groups), and residual (i.e., equal residual variances across groups) invariance. As measurement invariance involves evaluation of nested models, determination of model fit was based on a change in CFI ($\Delta CFI \leq 0.01$, change in RMSEA ($\Delta RMSEA \leq 0.015$, and change in SRMR ($\Delta SRMR \leq 0.030$ for metric invariance. For scalar and residual invariance, goodness-of-fit for the nested model was based on similar ΔCFI and $\Delta RMSEA$, but good model fit will have a $\Delta SRMR$ of ≤ 0.010 (Chen 2007). Weighted least square means and variance adjusted (WLSMV) estimator was used to evaluate measurement invariance when treating the data ordinality.

Within this dataset, some demographic subgroups received zero respondents to extreme response options (e.g., “Strongly

TABLE 2 | Brief suicide cognitions scale items and response frequencies.

Item	Strongly disagree	Disagree	Neutral	Agree	Strongly agree
1. I am completely unworthy of love.	1163	382	170	72	21
2. Nothing can help solve my problems.	1127	476	148	54	11
3. I can't cope with my problems any longer.	1220	397	131	52	12
4. I can't imagine anyone being able to withstand this kind of pain.	1234	302	160	90	26
5. There is nothing redeeming about me.	1221	373	129	75	14
6. Suicide is the only way to end the pain.	1610	140	43	14	5

Note: Scale items were derived from the original manuscript by Rudd and Bryan (2021).

TABLE 3 | Stepwise model comparison evaluating model fit for baseline ordinal CFA.

	X^2	Df	CFI	RMSEA	SRMR	TLI	ΔX^2
Model 1	209.75	9	0.991	0.108	0.028	0.984	—
Model 2	104.41	8	0.995	0.08	0.023	0.991	79.31***
Model 3	68.24	7	0.997	0.068	0.022	0.994	50.21***
Model 4	33.28	6	0.999	0.049	0.015	0.997	43.37***

Note: Scaled indices of fit are used for X^2 , CFI, RMSEA, and TLI. $N=1898$. Model 1: Baseline model with no items covarying. Model 2: Model allowing BSCS3 and BSCS4 to covary. Model 3: Model allowing BSCS3 and BSCS4, and BSCS2 and BSCS5 to covary. Model 4: Final model with BSCS3 and BSC4, BSCS2 and BSCS5, and BSCS2 and BSCS6 to covary.

*** $p < 0.001$ when comparing nested Chi-Square fit indices.

Agree”; see Supplemental Table S1) of B-SCS items. These incomplete item response matrices preclude the generation of polychoric correlation matrices, preventing the examination of measurement invariance when using the WLSMV estimator. As such, when necessitated, response categories were collapsed (e.g., “Agree” and “Strongly Agree” were collapsed to “Agree/Strongly Agree”; see Table S2) for both subgroups being compared. As collapsing item response categories can artificially improve model fit (Rutkowski et al. 2019) analyses using non-collapsed data treating the data continuously via maximum likelihood (ML) estimators were conducted for comparison. Results of measurement invariance analyses using ML estimators are only reported below when conclusions differed from WLSMV estimation methods.

In addition to assessing measurement invariance, internal consistency, concurrent validity, and construct validity were evaluated by comparing the B-SCS to the INQ, SIS, and IHS. Cronbach's alpha was calculated to assess internal consistency of the B-SCS, Pearson's r correlations were calculated between the B-SCS, INQ, SIS, and IHS to assess concurrent validity, and an independent samples t-test was conducted comparing B-SCS scores between participants who had and had not attempted suicide in their life to assess construct validity.

3 | Results

Initial CFA model fit for the B-SCS ($N=1898$) was evaluated using the WLSMV estimator (see Table 3). The baseline model showed modest fit ($\chi^2=209.75$, $df=9$, $p < 0.001$, CFI=0.991,

TLI=0.984, SRMR=0.028, RMSEA=0.108), with RMSEA exceeding the acceptable threshold. After evaluation of modification indices, allowing residual covariances among items 3–4, 2–5, and 2–6, yielded the best fit ($\chi^2=33.28$, $df=6$, $p < 0.001$, CFI=0.999, TLI=0.997, SRMR=0.012, RMSEA=0.049). All items loaded strongly (> 0.78 , $p < 0.001$), and a comparison of nested model goodness-of-fit favored the modified, more complex model ($\Delta X^2=43.37$, $p < 0.001$), supporting the final model for measurement invariance analyses.

For subgroups which required collapsing of item responses when evaluated ordinally, a CFA model treating variables continuously ($N=1898$) was established using non-collapsed item responses and was used to evaluate measurement invariance for those models. Results of continuous models are presented in the supplemental materials (see Table S3) and are noted in this document only where results differed across analytic approaches.

3.1 | Measurement Invariance

3.1.1 | Gender

Assessment of measurement invariance was conducted between cisgender women ($n=1437$) and cisgender men ($n=375$). As not all items were completed within the item response matrix, B-SCS responses “Agree” and “Strongly Agree” were collapsed. The configural model demonstrated good fit ($X^2=33.31$, $df=12$, $p < 0.001$, CFI=0.999, TLI=0.998, SRMR=0.017, RMSEA=0.044). Subsequent steps of measurement invariance held for metric invariance ($\Delta CFI=0.000$, $\Delta RMSEA=-0.006$, $\Delta SRMR=0.004$), scalar

invariance ($\Delta\text{CFI}=0.000$, $\Delta\text{RMSEA}=-0.006$, $\Delta\text{SRMR}=-0.002$), and residual invariance ($\Delta\text{CFI}=0.000$, $\Delta\text{RMSEA}=-0.001$, $\Delta\text{SRMR}=0.002$). Fit statistics for measurement invariance models of ordinal data can be found in Table 4.

3.1.2 | Sexuality

Assessment of measurement invariance was conducted comparing heterosexual ($n=1510$) to sexual minority ($n=354$) participants. Sexual minority participants included those who identified as asexual, bisexual, demisexual, gay, lesbian, pansexual, queer, questioning, or no label. This did not include those who did not disclose their sexuality ($n=27$). The configural model demonstrated good fit ($X^2=45.18$, $p<0.0001$, $df=12$, $\text{CFI}=0.999$, $\text{TLI}=0.998$, $\text{SRMR}=0.016$, $\text{RMSEA}=0.054$). Subsequent steps held for

metric ($\Delta\text{CFI}=0.000$, $\Delta\text{RMSEA}=-0.013$, $\Delta\text{SRMR}=0.003$), scalar ($\Delta\text{CFI}=0.000$, $\Delta\text{RMSEA}=-0.009$, $\Delta\text{SRMR}=-0.002$), and residual ($\Delta\text{CFI}=0.000$, $\Delta\text{RMSEA}=0.004$, $\Delta\text{SRMR}=0.002$) invariance.

3.1.3 | Ethnicity

Assessment of measurement invariance was conducted comparing Hispanic ($n=184$) and non-Hispanic ($n=1714$) participants. As not all items were completed within the item response matrix, response options "Agree" and "Strongly Agree" were collapsed for evaluation. The configural model demonstrated good fit ($X^2=33.287$, $p<0.0001$, $df=12$, $\text{CFI}=0.999$, $\text{TLI}=0.998$, $\text{SRMR}=0.018$, $\text{RMSEA}=0.043$). Subsequent analyses held when evaluating for metric ($\Delta\text{CFI}=0.000$, $\Delta\text{RMSEA}=-0.016$, $\Delta\text{SRMR}=0.000$), scalar ($\Delta\text{CFI}=0.000$, $\Delta\text{RMSEA}=-0.007$,

TABLE 4 | Fit statistics across all ordinal measurement invariance models.

	X^2	df	CFI	RMSEA	SRMR	TLI	ΔCFI	ΔRMSEA	ΔSRMR
Gender: Cisgender man ($n=375$): Cisgender woman* ($n=1437$)									
Configural	33.31	12	0.9990	0.044	0.017	0.9976			
Metric	39.19	17	0.9989	0.038	0.021	0.9982	-0.000	-0.006	0.004
Scalar	54.24	28	0.9988	0.032	0.019	0.9987	-0.000	-0.006	-0.002
Residual	64.42	34	0.9986	0.031	0.021	0.9988	-0.000	0.001	0.002
Ethnicity: Hispanic ($n=184$): Non-Hispanic* ($n=1714$)									
Configural	33.29	12	0.9991	0.043	0.018	0.9978			
Metric	29.16	17	0.9995	0.027	0.018	0.9991	0.000	-0.016	0.000
Scalar	38.70	28	0.9996	0.020	0.018	0.9995	0.000	-0.007	0.000
Residual	43.55	34	0.9996	0.017	0.018	0.9997	0.000	-0.003	0.000
Sexuality: Heterosexual ($n=1510$): Sexual minority ($n=354$)									
Configural	45.18	12	0.9986	0.054	0.016	0.9963			
Metric	44.12	17	0.9988	0.041	0.019	0.9974	0.000	-0.013	0.003
Scalar	67.24	34	0.9985	0.032	0.017	0.9989	-0.000	-0.009	-0.002
Residual	87.10	40	0.9979	0.036	0.019	0.9984	-0.000	0.004	0.002
Race: Black ($n=380$): White ($n=1127$)									
Configural	49.24	12	0.9979	0.064	0.018	0.9940			
Metric	56.12	17	0.9979	0.055	0.026	0.9962	-0.000	-0.009	0.008
Scalar	81.71	34	0.9974	0.043	0.023	0.9977	-0.000	-0.012	-0.003
Residual	110.44	40	0.9961	0.048	0.026	0.9971	-0.001	0.005	0.003
Race: Asian American ($n=106$): White* ($n=1127$)									
Configural	31.22	12	0.9988	0.051	0.022	0.9969			
Metric	37.20	17	0.9987	0.044	0.026	0.9977	-0.000	-0.007	0.004
Scalar	48.81	28	0.9987	0.035	0.023	0.9986	-0.000	-0.009	-0.003
Residual	57.57	34	0.9985	0.034	0.026	0.9987	-0.000	-0.001	0.002

Note: Data were treated as ordinal and Diagonally Weighted Least Squares estimator was used. Model goodness-of-fit was based on Chen (2007). Comparisons of race were specifically non-Hispanic Black, non-Hispanic White, non-Hispanic and Asian American. Comparison of Ethnicity included anyone that identified as Hispanic compared to anyone that did not identify as Hispanic.

*Indicates samples that had scale responses 4 ("Agree") and 5 ("Strongly Agree") collapsed for analysis.

$\Delta\text{SRMR}=0.000$), and residual ($\Delta\text{CFI}=0.000$, $\Delta\text{RMSEA}=-0.003$, $\Delta\text{SRMR}=0.000$) invariance.

3.1.4 | Race

Assessment of measurement invariance was conducted comparing races across participants. Sufficient sample sizes were present for comparison between White ($n=1127$) participants with Black ($n=380$) and Asian American ($n=106$) participants. When evaluating measurement invariance between White and Black participants, measurement invariance was maintained across configural ($X^2=49.25$, $p<0.0001$, $\text{df}=12$, $\text{CFI}=0.998$, $\text{TLI}=0.998$, $\text{SRMR}=0.018$, $\text{RMSEA}=0.064$), metric ($\Delta\text{CFI}=0.000$, $\Delta\text{RMSEA}=-0.009$, $\Delta\text{SRMR}=0.008$), scalar ($\Delta\text{CFI}=0.000$, $\Delta\text{RMSEA}=-0.012$, $\Delta\text{SRMR}=-0.003$), and residual ($\Delta\text{CFI}=0.001$, $\Delta\text{RMSEA}=0.005$, $\Delta\text{SRMR}=0.003$) models.

As not all items were completed within the item response matrix, response options “Agree” and “Strongly Agree” were collapsed for evaluation of measurement invariance between white ($n=1127$) and Asian American ($n=106$) participants. When evaluating measurement invariance between participants who were White and participants who were Asian, results yielded good fit across configural ($X^2=31.22$, $p<0.0001$, $\text{df}=12$, $\text{CFI}=0.999$, $\text{TLI}=0.997$, $\text{SRMR}=0.022$, $\text{RMSEA}=0.051$) and subsequent nested models of metric ($\Delta\text{CFI}=0.000$, $\Delta\text{RMSEA}=-0.007$, $\Delta\text{SRMR}=0.004$), scalar ($\Delta\text{CFI}=0.000$, $\Delta\text{RMSEA}=-0.009$, $\Delta\text{SRMR}=-0.003$), and residual ($\Delta\text{CFI}=0.000$, $\Delta\text{RMSEA}=-0.001$, $\Delta\text{SRMR}=0.002$) invariance.

When treated as continuous, measurement noninvariance occurred for configural invariance ($X^2=60.52$, $\text{df}=12$, $p<0.001$, $\text{CFI}=0.987$, $\text{TLI}=0.968$, $\text{SRMR}=0.022$, $\text{RMSEA}=0.081$). As a result, invariance testing was discontinued. An examination of configural invariance models evidenced noticeably different factor loadings across White and Asian American participants for items 3 (0.763 and 0.657), 4 (0.696 and 0.575), and 6 (0.530 and 0.712), respectively.

3.1.5 | Measurement Invariance of a Simplified Single-Factor Model

As the optimal model for measurement invariance utilized a super-fitted model involving residual covariances of B-SCS items, measurement invariance was also examined using the unfitted, single-factor model without correlated residual covariances. These analyses yielded measurement invariance at all levels across all subgroups analyzed in this study. This additional series of analyses was conducted to ensure the B-SCS is measurement invariant as it would be used and scored in standard practice (see Table S4).

3.2 | Psychometric Validity and Reliability

Internal consistency was evaluated ($N=1898$), yielding an average inter-item correlation across variables of 0.59, with results ranging from 0.4 to 0.71. Overall, the B-SCS showed strong internal consistency ($\alpha=0.88$).

Construct validity was evaluated on a subset of participants who had responded to all questions ($n=1839$). To evaluate construct validity, a comparison of total B-SCS scale score was conducted between participants who had attempted suicide in their lifetime ($n=201$) and those who had not ($n=1638$). As the data were positively skewed, Welch's *t*-test was used. Results of the Welch's two-sample *t*-test indicated that there were significantly different overall B-SCS scale scores between those who had attempted suicide ($M=12.6$, $\text{SD}=5.20$) and those who had not attempted suicide ($M=8.45$, $\text{SD}=3.58$, $t(223.9)=-11.05$, $p<0.001$, $d=-0.93$).

A subset of participants with complete data for the B-SCS, IHS, INQ, and SIS ($n=1609$) was evaluated for concurrent validity. Pearson product moment correlation coefficients were calculated for comparisons between the B-SCS and the identified theoretically related constructs. The B-SCS total score was strongly correlated with the SIS ($r(1607)=0.64$, $p<0.001$) and with perceived burdensomeness scale scores from the INQ ($r(1607)=0.62$, $p<0.001$). Correlation analyses indicated a moderate relationship between the B-SCS scale score and the IHS perceived burdensomeness ($r(1607)=0.47$, $p<0.001$) and thwarted belongingness ($r(1607)=0.54$, $p<0.001$) subscale scores, and with the INQ thwarted belongingness subscale score ($r(1607)=0.54$, $p<0.001$).

As was completed by Rudd and Bryan (2021) assessment of concurrent validity was conducted with the removal of one item that explicitly mentions “suicide” (item #6) and thus can contaminate any relationships with suicidal thinking. As was expected, the relationship between B-SCS and all similar constructs remained significant and maintained moderate to strong correlations ranging from 0.53 to 0.60.

4 | Discussion

The present study aimed to extend research on the psychometric properties of the B-SCS. Results from measurement invariance analyses across gender, sexuality, and race (White vs. Black) indicated the B-SCS to be measurement invariant across all levels of analysis when treated ordinarily. These results suggested that the B-SCS factor loadings, thresholds, and residual variances were equivalent across groups. For groups evaluated utilizing continuous model estimators (i.e., gender, ethnicity, and race), results also supported measurement invariance across all levels between genders (cisgender women vs. cisgender men), ethnicity (Hispanic vs. non-Hispanic), and race (White vs. Black).

Prior to the evaluation of measurement invariance, CFA models were compared to determine optimal model fit within this data. This resulted in a model which necessitated the inclusion of residual covariances for items 3 and 4, 2 and 5, and 2 and 6. The final CFA model used in this investigation allowed residual covariances across select pairs of items to improve model fit. As these items are aimed at representing a general suicidal belief system, there is substantive overlap between the content of the questions. For example, Item 3 (“I can't cope with my problems any longer.”) and Item 4 (“I can't imagine anyone being able to withstand this kind of pain.”) are both items derived from the “unbearability” subfactor of the SCS, and Item 2 (“Nothing can help me solve my problems.”) and Item 6 (“Suicide is the only way to end this pain.”)

are derived from the “unsolvability” subfactor when evaluated via a three-factor structure (Ellis and Rufino 2015). However, Item 2 and Item 5 (“There is nothing redeeming about me.”) are derived from the unlovability subfactor when evaluated as a two-factor structure (Bryan et al. 2014). As such, the presence of these residual covariances was consistent with theoretically established suicidogenic cognitions which are better explained by the overall suicidal belief system.

For Asian American participants, the B-SCS was found to be measurement invariant when collapsed and evaluated ordinarily, but not when treated continuously. This inconsistency may be due to limitations associated with the data structure and parameter estimators being used. As indicated by Li (2016), ML estimators are more sensitive to skewed data when compared to robust methods such as WLSMV, which may result in model misfit at the configural level. However, research has found Asian and White participants to differentially endorse reasons for suicidal thoughts (Ammerman et al. 2019); these results may be indicative of differences in the ways in which Asian American participants experience suicidogenic cognitions compared to White participants. Future research may seek to compare the ways in which suicidogenic cognitions are experienced between White and Asian American participants to better understand if these differences are present.

Overall, results from measurement invariance analyses yielded support for the generalizability of the B-SCS across cisgender men and women, heterosexual and sexual minority, Hispanic and non-Hispanic, and Black and White participants. The presence of scalar invariance indicates that a similar latent variable (e.g., the suicidal belief system) is being measured to a similar degree across subgroups. Further, the presence of residual invariance indicates that equal error variance is present. Establishing measurement invariance ensures that the observed group differences on the B-SCS can be interpreted as true differences in the underlying construct (i.e., the suicidal belief system) rather than measurement bias. Thus, these findings indicated that the B-SCS can be used to compare group mean scores of the B-SCS groups found to be measurement invariant in the present investigation. As noted by Hatzenbuehler (2009), negative cognitive schemas may mediate the effects of stigma-related stressors and the development of psychopathology; measurement invariance of the B-SCS allows researchers to better understand how the relationship between minority-specific stressors and psychopathology may be related to unique experiences of minoritized groups.

Additionally, measurement invariance analyses of a simpler, common factor model, as would be typically used in research and clinical settings, yielded support for measurement invariance at all levels for all analyses. Of note, despite results indicating measurement invariance, several of these models retain RMSEA values typically deemed unacceptable, based on the recommendations of Hu and Bentler (1999).

Finally, results from evaluations of internal consistency suggested the B-SCS to be a reliable instrument which measures a uniform construct. Likewise, the B-SCS demonstrated good construct validity, as it was significantly and positively correlated

with measures of similar constructs (e.g., hopelessness and suicidal ideation). Additionally, the B-SCS was able to significantly differentiate participants who had and had not attempted suicide. This provides potential support for the B-SCS in capturing the enduring risk hypothesized to exist within the suicidal belief system (Rudd 2006), although alternative explanations for this finding cannot be ruled out (e.g., psychological scarring hypothesis; Liu 2019).

These results are not without limitations. Sparse data precluded assessment of measurement invariance for the B-SCS as the scale was originally developed in demographic subgroups. Collapsing of response categories may inflate model fit, resulting in type I errors when determining if the scale is measurement invariant. Additionally, collapsing the data has the potential to alter the CFA model fit. Although this was not the case in this study, results from measurement invariance analyses where item responses are collapsed should be interpreted with caution. Moreover, sample sizes of select subgroups were quite small (e.g., Asian American $n=106$); although recommendations for sample size requirements range from 100 to 500 (Bandalos 2014), a larger sample size ensures appropriate model and error estimations. Finally, this study was conducted in a sample of college students. However, approximately 16.6% of this sample endorsed past-year suicidal ideation, indicating a need for understanding and evaluating suicidogenic cognitions among non-clinical, college-aged populations. Nonetheless, it is integral to evaluate psychometric properties of the B-SCS within different populations, as suicidogenic cognitions may manifest differently across groups (e.g., among those in acute psychiatric care).

Further analyses should aim to continue evaluating psychometrics of the B-SCS across populations and over time, specifically examining the degree to which the B-SCS is stable over time and if it is measurement invariant across different participant populations (e.g., those who have attempted suicide and those who have never attempted suicide). Additionally, due to limited sample size across subgroups, these results may not generalize to all populations. For example, it is important to ensure the B-SCS generalizes to different sexual minority groups equally (e.g., bisexual compared to lesbian or gay individuals), as research indicates these groups may experience suicidal thoughts and behaviors differently (Ramchand et al. 2022). Finally, as the B-SCS contains a single item which explicitly mentions suicide, future research may seek to evaluate the influence this item has on overall B-SCS ratings, and if the B-SCS holds predictive or incremental validity with and without the inclusion of this item. This is of importance, as the inclusion of questions explicitly asking about suicide may result in under-reporting among participants.

Despite these limitations, this study provided an integral step forward in adding to the literature evaluating the psychometric reliability and validity of the B-SCS. These results provide support indicating that the B-SCS is a psychometrically sound tool for evaluating suicidogenic cognitions across diverse populations of college students. Confirmation of the unidimensional structure of the B-SCS provided further support for the potential existence of a latent, underlying construct predisposing individuals to increased suicide risk.

Ethics Statement

All procedures were approved by the university Institutional Review Board.

Conflicts of Interest

The authors declare no conflicts of interest.

Data Availability Statement

The data that support the findings of this study are available from the corresponding author upon reasonable request.

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Supporting Information

Additional supporting information can be found online in the Supporting Information section. **Table S1:** Item response frequencies across subgroups compared for measurement invariance. **Table S2:** Subgroups of participants which had adjacent item response categories collapsed due to incomplete item response matrices. **Table S3:** Fit statistics from all continuous measurement invariance models. **Table S4:** Fit statistics across simple ordinal measurement invariance models.