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An exploratory investigation of the reliability and validity of the Independent-Interdependent Problem-Solving Style Scale

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The Independent-Interdependent Problem-Solving Scale is based on Cross et al.'s conceptualisation of relational-interdependent self-construal. The IIPSS provides a relatively context-free measure of people's tendencies to solve problems independently or with the help of others. Because previous investigations have not provided extensive evidence for the reliability and validity of the IIPSS, the current research aimed to test the psychometric properties of this novel measure. Investigations of four student samples (combined $N = 1157$) and one sample comprised of academic researchers ($N = 198$) generally supported the reliability and validity of the IIPSS. Exploratory factor analysis of IIPSS items yielded a single factor structure. However, confirmatory factor analyses did not demonstrate good model fit for the one factor solution and instead yielded good model fit for two underlying factors. The IIPSS showed adequate test–retest reliability and predicted positive associations with social personality traits. It also showed no significant associations with measures of demand characteristics and social desirability. Future research needs to be undertaken to further assess the factor structure and address shortcomings of the present research such as utilising objective data in addition to self-reports to assess the scale's validity.

Keywords: Problem-solving; Scale measure; Reliability; Validity.

Everyday problem-solving situations can be approached alone or with the help of other people. This distinction between *independent* and *interdependent* problem-solving is modelled after Cross et al.'s (2000) concept of independent and relational self-construal, according to which an individuals' self-representation can be either centred around their own attributes, such as their abilities and characteristics, or representations of significant others, such as their partners, family and friends. Based on this conceptualisation, Rubin et al. (2012) assumed that people with greater independent self-views are more likely to prefer independent problem-solving, and people with greater interdependent self-views are more likely to prefer interdependent problem-solving. For example, a preference to solve everyday problems in a self-reliant manner across different types of problems (e.g., relationship or scholarly problems) and domains (e.g., private, work-related, or academic domains) would indicate that a person leans towards having an independent problem-solving style. Similarly, a preference to tackle these sorts of problems by consulting with others when possible would indicate a tendency for interdependent problem-solving. The present research aimed to provide evidence for the reliability and validity of an Independent-Interdependent Problem-Solving Scale (IIPSS; Rubin et al., 2012).

Previous research on independent and interdependent problem-solving

Previous research has shown that differences in habitual tendencies to either solve problems alone or with the help of other people can have implications for socio-psychological functioning. For example, respondents' tendencies towards interdependent problem-solving were associated with relational-interdependent self-construal and an extraverted personality (Rubin et al., 2012). A recent publica-

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tion further demonstrated that closed-minded individuals (the opposite pole of the Big Five openness to experience trait dimension) who tended to be independent problem solvers reported higher levels of negative affect compared to more interdependent problem-solvers (Sanatkar & Rubin, 2020). In addition, Ainsworth and Oldfield (2019) found that, among UK teachers, independent problem-solving was positively related to perceived conflict between teaching beliefs and practices and negatively related to emotional intelligence, life-orientation and self-care.

The degree to which individuals perceive others as a supportive resource may also vary by gender and socio-economic status. Women tend to have greater relational self-construal than men and show more interdependent tendencies compared to men in a wide variety of cognitions and behaviours (Cross et al., 2000; Cross & Madson, 1997). Consistent with these findings, stressed female students have been found to seek social support from family and friends, while men endorse self-reliance in potential help-seeking situations (Addis & Mahalik, 2003; Day & Livingstone, 2003). Previous research has also found that advice giving and receiving is more prevalent in individuals who identify as middle-class, whereas self-reliance is more apparent in people who identify as working class (Bowman et al., 2009). It is therefore possible that men and working-class people have a more independent problem-solving style, while women and middle-class people have a more interdependent problem-solving style.

Exploring the psychometric properties of the IIPSS

Various scales exist that examine how people attempt to solve every day problem-solving situations and the degree to which individuals solve problems in a collaborative way (Anderson et al., 1998; Cutrona & Russell, 1987; Karabenick & Knapp, 1991; Wilson et al., 2005). Most of these measures were developed in the areas of everyday, personal and social problem-solving and decision-making. The IIPSS (Rubin et al., 2012) is different from these other scales because (a) it focuses on whether or not people tend to seek and use the advice from others in order to solve their problems; (b) it aims to provide a general measure that relates to a wide range of contexts and tasks; and (c) it specifically contrasts independent problem-solving with interdependent problem-solving. Although the IIPSS has been used in various research studies (Ainsworth & Oldfield, 2019; Akinbobola et al., 2018; Alexander & Beckerling, 2013; Dorgan, 2018; Sanatkar & Rubin, 2020; Seward & Harris, 2016; Vieira, 2013), its psychometric properties have not yet been sufficiently established.

To our knowledge, previous research has not yet examined whether the IIPSS shows expected correlations with related interpersonal measures. Based on the assumption that the IIPSS measures problem-solving preferences in everyday situations, it should have small-to-medium correlations with help-seeking, decision-making and social support measures given that these dimensions should show some overlap with the social problem-solving domain assessed in the IIPSS. In other words, preferences for interdependent problem-solving should be positively related to willingness to seek help, collaborative decision-making and seeking social support because they all describe actions of a relational nature as described in collectivist and relational self-construal theory (Triandis, 2001). However, relatively high correlations between the IIPSS and any of these related measures would indicate that the construct of independent versus interdependent problem-solving style may be redundant.

Empirical work has also yet to establish a clear picture of the dimensionality of the IIPSS. Initial investigations of the Relational-Interdependent Self-Construal scale yielded a single factor structure (Cross et al., 2000). However, several researchers have noted a two-factor structure for the associated concepts of independence versus interdependence (Oyserman et al., 2002; Singelis, 1994; Trafimow et al., 1991; Triandis et al., 1986). A meta-analysis of 149 research studies found that more specific measures with a limited range of item domains, reference targets and statement types suited a single factor structure better than more global measures with a greater range of item complexity (Taras et al., 2014). Hence, the IIPSS may be expected to have either a single factor structure, because it represents a relatively specific construct, or a two-factor structure, because it applies to a wide range of problem-solving types and contexts.

Prior investigations of the factor structure of the IIPSS have yielded inconsistent results (Rubin et al., 2012; Vieira, 2013). Exploratory factor analysis initially yielded a single factor structure that explained 33% of the variance (eigenvalue = 3.96) in a pilot sample of 312 Australian university students (Rubin et al., 2012). However, Vieira's factor analysis yielded a two-factor solution for independent and interdependent problem-solving. The independent problem-solving style factor explained 33% of the variance, and the interdependent problem-solving style factor explained 23% of the variance. Thus, it is unclear whether the typical factor structure of the IIPSS is one- or two-factorial. Moreover, other reliability estimates, such as the test–retest reliability of the IIPSS, have not been reported to date.

Finally, it is common to require a psychometric measure to be unrelated to demand characteristics and social desirability (King & Bruner, 2000; Strohmetz, 2008; van de Mortel, 2008). Demand characteristics, as described by Orne (1962), are specific cues of the experimental situation that raise participants' awareness of the research aims and, as a result, may alter participants' naturalistic responses. Social desirability describes the tendency of

research participants to convey a favourable image of themselves (Paulhus, 1984; van de Mortel, 2008). A scale's validity is weakened when responses are confounded with either demand characteristics or socially desirable response patterns (King & Bruner, 2000; Rubin, 2016). Consequently, it is important to check whether the IIPSS is associated with either of these issues.

Overview of the current research

The aim of the current research was to provide an empirical examination of the psychometric properties of the IIPSS. In particular, we aimed to investigate the IIPSS's (a) factor structure, (b) test–retest reliability, (c) previously reported associations with relational-interdependent self-construal and extraversion (Rubin et al., 2012), (d) associations with other relational measures and behaviours, (e) associations with gender and social class, and (f) associations with measures of demand characteristics and social desirability.

Note that the analyses in this article were not preregistered. There is an ongoing debate about the meaning of frequentist null hypothesis significance testing and associated *p*-values in non-preregistered exploratory research (de Groot, 2014; Rubin, 2017). Following Rubin (2017), we used frequentist testing in the current study given that we restricted our statistical inferences to decisions about single tests of individual null hypotheses.

METHOD

Participants

Undergraduate students from an Australian university completed Studies 1, 2, 4, and 5, and academic researchers from mostly European, Asian, and Northern American universities completed Study 3. Sample sizes ranged from 186 to 399. Sample sizes, ages, gender distributions and other sample characteristics are listed in Table 1.

Students received course credit for their study participation, and academics were given the opportunity to enter a prize draw in which they had a 1 in 40 chance of winning a $200 gift voucher. To examine the test–retest reliability of the IIPSS, we analysed the responses of 117 student participants who completed the IIPSS in Study 1 and then again in Study 4 between 4 and 12 months later.

All procedures performed in studies involving human participants were in accordance with the ethical standards of the University of Newcastle Human Research Ethics Committee and with the 1964 Helsinki Declaration and its later amendments or comparable ethical standards.

The research presented in this work involved five studies, some of which combined research aims that are not included in this article. As a consequence, not all measures, conditions, or data collected are included in this work. However, all participants were included provided they did not withdraw their informed consent to participate. We did not seek permission from participants to make deidentified data available as per the open science framework. Consequently, data is not publicly available due to ethical restrictions.

TABLE 1
Sample sizes, ages and gender distributions, and occupations in Studies 1–5

		Age		Gender		
Study	*N*	*M*	*SD*	*Men*	*Women*	*Occupation*
1	399	21.56	5.59	91	308	Students
2	186	23.53	8.02	36	148	Students
3	198	44.07	11.19	62	130	Academics
4	337	22.27	6.36	60	277	Students
5	235	23.27	6.83	55	179	Students

Note: $n = 117$ student participants completed Studies 1 and 4.

Measures

Unless otherwise indicated, participants made their responses using a 7-point Likert-type scale anchored *strongly disagree* and *strongly agree*.

Problem-solving style

Individual differences in independent-interdependent problem-solving were measured using Version 2 of the IIPSS (Rubin, 2011). The initial version of the IIPSS has good convergent and divergent validity as well as good reliability (Rubin et al., 2012), and Version 2 has satisfactory reliability (Vieira, 2013). We coded the IIPSS in such a way that higher scores indicated a greater *independent* problem-solving style. This procedure is consistent with the scoring method described by Rubin et al. (2012).

Problem-solving behaviour

In Study 4, student participants' recent problem-solving behaviours at university were assessed using six ad hoc items that described various ways in which participants may have sought instrumental help at university. Participants were asked to think of an academic problem that they had encountered in the past week and then to indicate whether they had used any of the six provided options. The problem-solving behaviours showed various degrees of interpersonal problem-solving (e.g., "asked another student," "asked staff in the Student Hubs"). Responses were made on a 5-point Likert-type scale ranging from *not at all* to *very much*.

Personality traits

In Studies 1, 2, 3, and 5, the Big Five personality traits were assessed with the 44-item Big Five Inventory (John & Srivastava, 1999). In Study 4, we used the 10-item short version of the BFI.

Relational-interdependent self-construal

In Study 4, student participants responded to items assessing interdependent self-construal using the Relational-Interdependent Self-Construal scale (Cross et al., 2000). This scale measures independent and relational (i.e., interdependent) self-views in Western societies (e.g., the United States or Australia).

Help-seeking scales

Student participants' help-seeking tendencies were assessed in Study 4 using measures of general help-seeking, collaboration in decision-making, social provisions and students' help-seeking tendencies.

The General Help-Seeking Questionnaire (Wilson et al., 2005) assesses willingness to seek help from eight specific people such as family members, a friend or a counsellor when facing (a) general personal problems or (b) a suicidal crisis. The degree to which participants were willing to collaborate in decision-making situations was assessed using the 13-item Decision-Making Collaboration Scale (Anderson et al., 1998), and the 24-item Social Provisions Scale (Cutrona & Russell, 1987) measures the degree to which social relationships provide social support and fulfil interpersonal needs.

The 18-item Assessment of Achievement-Related and Help-Seeking Tendencies scale (Karabenick & Knapp, 1991) measures students' behaviours to counteract poor performance outcomes at university. For example, students are instructed to indicate how likely they would take actions such as "seek help from support services" and "study more" if they were experiencing poor academic performance.

Social desirability and demand characteristics

To investigate participants' tendencies to present themselves favourably, participants in Studies 2 and 4 completed the impression management subscale of Version 6 of the Balanced Inventory of Desirable Responding scale (Paulhus, 1991). The BIDR−6 Form 40 consists of two subscales, impression management and self-deceptive enhancement. According to Paulhus, "it is recommended that impression management, but not self-deception, be controlled in self-reports of personality" (p. 598). In line with Paulhus' recommendations, we included only the 20-item impression management subscale of the measure.

To examine the potential influence of demand characteristics, we included the four-item Perceived Awareness of the Research Hypothesis scale (Rubin, 2016) in Studies 1, 2, and 4. The PARH scale assesses participants' perceived awareness of the research hypothesis in a closed-ended, quantitative way.

Sensitivity analysis

The smallest sample size presented in this article was $N = 186$ (Study 2). A sensitivity analysis found that a two-tailed bivariate correlation analysis with an alpha level of .05 and a power level of .80 would be able to detect an effect size of $r = .20$ using this sample size. An effect size of around $r = .20$ is typical in the area of individual differences (e.g., Gignac & Szodorai, 2016). Hence, the sample sizes in this research generally have good power to detect the typical effect sizes in this area.

RESULTS

Factor structure

Exploratory factor analysis

We investigated the factor structure of the IIPSS's independent items and reverse scored interdependent items using a principal axis factor analysis with promax rotation. For Study 1, the Kaiser−Meyer−Olkin value exceeded .86, which suggested that the sample was adequate to perform exploratory factor analysis (Kaiser, 1974). We used two approaches to determine the number of factors to extract. First, we used Cattell's scree plot approach, in which we inspected a graphical representation of the eigenvalues in descending order. Figure 1 shows the scree plot of the Study 1 data set, which suggested that the slope tails off after the first factor.

To determine whether to retain the factor in the elbow, we employed a second approach. We conducted a parallel analysis using Monte Carlo simulation, which generates a series of data sets that simulate the experimental data. If the eigenvalues of the factors from the experimental data set are larger than those for the simulated data set, then it can be concluded that the respective factors are present in the data set. The results of the parallel analysis showed that the eigenvalue of the first factor (4.75) exceeded the eigenvalue of the first factor in the simulated data set (1.25). However, the eigenvalue of the second factor (1.10) did not exceed the second factor in the simulated data (1.17). Consequently, we specified the extraction of only one factor using the promax method of oblique rotation. We set the Kappa value to 3. According to Tataryn et al. (1999), this provides the least error and bias. Table 2 displays the loadings of the one factor solution in the resulting factor matrix. All items had factor loadings that

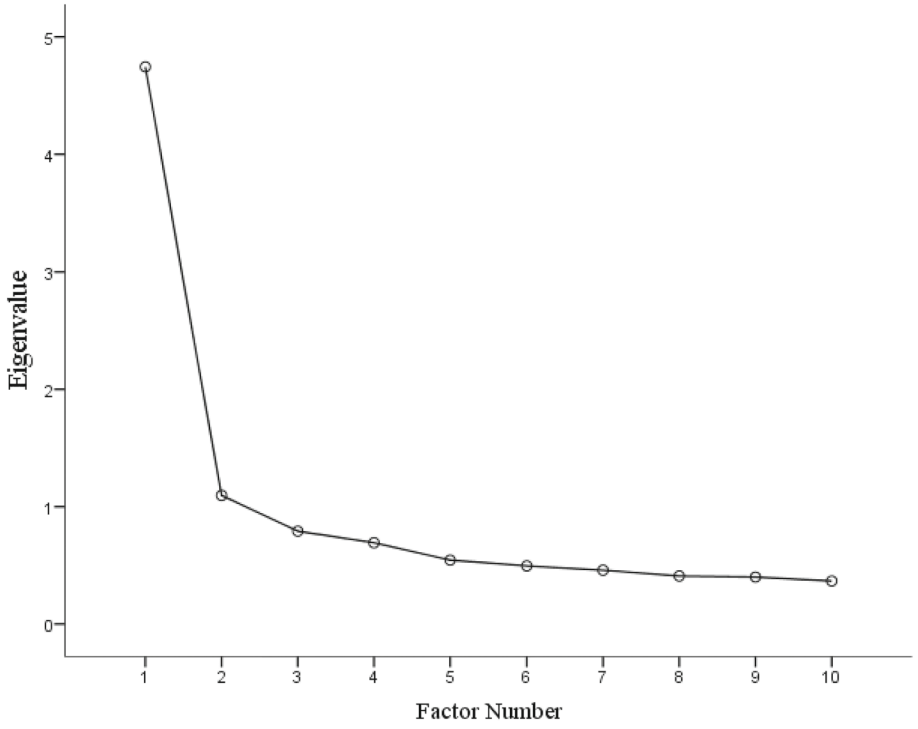

Figure 1. Cattell's scree plots for IIPSS items in the first sample.

TABLE 2
Inter-item correlations and internal consistencies (McDonald's omegas) for the 10-item IIPSS Version 2 across Studies 1–5

	Study				
Item	*1*	*2*	*3*	*4*	*5*
(1) In general, I do not like to ask other people to help me to solve problems.	.76	.74	.66	.79	.72
(2) I like to get advice from my friends and family when deciding how to solve my personal problems.∗	.70	.73	.61	.69	.76
(3) I prefer to make decisions on my own, rather than with other people.	.67	.64	.70	.70	.70
(4) I do not like to depend on other people to help me to solve my problems.	.66	.58	.67	.63	.62
(5) I would rather struggle through a personal problem by myself than discuss it with a friend.	.65	.66	.60	.71	.63
(6) I usually prefer to ask other people for help rather than to try to solve problems on my own.∗	.64	.54	.41	.61	.64
(7) I prefer to consult with others before making important decisions.∗	.63	.71	.62	.73	.72
(8) I usually find other people's advice to be the most helpful source of information for solving my problems.∗	.63	.65	.56	.69	.64
(9) I value other people's help and advice when making important decisions.∗	.58	.56	.50	.61	.59
(10) When faced with a difficult personal problem, it is better to decide yourself rather than to follow the advice of others.	.55	.48	.65	.57	.56
McDonald's omega value	.87	.86	.85	.89	.89

Note: Items with an asterisk are reverse scored.

exceeded the cut-off criteria of .40 and ranged between .41 and .79. Internal consistency of IIPSS items was high across all studies, with McDonald's omega coefficients of the items ranging from .85 to .89 (Hayes & Coutts, 2020).

Confirmatory factor analysis

We conducted confirmatory factor analyses of Studies 2 to 5 to test the assumption that the IIPSS has a single-factor structure. Table 3 presents the results of the confirmatory factor analyses using Amos 26.0.0 software. The fit indices did not reach very good fit standards, with root mean square error of approximation values on or slightly above the threshold of .10 and the comparative fit index remaining below .95 (Hooper et al., 2008). The comparative fit index was marginally acceptable (≥.90) only in Study 5 (Bagozzi, 2010). Based on recommendations to consider previous research findings and theory in determining the number of factors to retain (Fabrigar et al., 1999), we repeated the analyses assuming a two-factor structure to examine whether the model fit would improve. The results of the confirmatory factor analysis with a two-factor solution are shown in Table 3. The comparative fit indices improved consistently, and the

TABLE 3
Confirmatory factor analyses for Studies 2–5 assuming that IIPSS items measure one (left) or two (right) latent factor(s)

	One factor solution							*Two factor solution*						
						90% CI							*90% CI*	
Study no.	χ^2	*df*	*p*	*CFI*	*RMSEA*	*Low*	*High*	χ^2	*df*	*p*	*CFI*	*RMSEA*	*Low*	*High*
Study 2	134.92	35	<.001	.85	.12	.10	.14	57.93	34	.006	.96	.06	.03	.09
Study 3	105.954	35	<.001	.87	.10	.08	.12	76.15	34	<.001	.93	.08	.06	.10
Study 4	257.65	35	<.001	.85	.14	.12	.15	104.18	34	<.001	.95	.08	.06	.09
Study 5	129.13	35	<.001	.91	.10	.08	.12	89.12	34	<.001	.95	.08	.06	.10

Note: χ^2 = chi-square statistic, *df* = degrees of freedom, *p* = significance level, CFI = comparative fit index, RMSEA = root mean square error of approximation, CI = 90% confidence interval for the lower and upper bounds of the RMSEA value.

upper bounds of the root mean square error of approximation values also remained on or below the .10 threshold across studies. Hence, confirmatory factor analysis suggested a two-factor solution to be superior to a single factor structure.

Test–retest reliability

Confirming the stability of the IIPSS, the measure showed adequate test–retest reliability of IIPSS scores of student participants who completed Studies 1 and 4 with a correlation coefficient of .79 across two time points that were between 4 and 12 months apart. Furthermore, model comparisons between assessments at Time 1 and Time 2 did not indicate significant deviations from factor loading, $\chi^2(9) = 5.93, p = .747$; structural covariance, $\chi^2(1) = .65$, $p = .420$; and measurement residual, $\chi^2(10) = 6.21$, $p = .798$, invariance assumptions, indicating that equivalence of the IIPSS over time could be assumed.

Criterion-related validity

Investigations of the criterion-related validity of the IIPSS in Study 4 confirmed that university students who had an interdependent problem-solving style (i.e., lower scores on the IIPSS) reported engaging in interdependent problem-solving behaviours in the weeks prior to their research participation. As seen in Table 4, two interdependent problem-solving behaviours—"asked another student" and "asked a tutor or lecturer"—were significantly and negatively related to problem-solving style (*r*s = −.30 and −.19, respectively). However, the remaining four problem-solving behaviours were not significantly related to problem-solving style (*r*s ranged between −.09 and .01).

General preferences for independence and interdependence

To test whether each sample of participants tended to prefer independent or interdependent problem-solving, we examined participants' mean scores on the IIPSS. Using classical and Bayesian one sample *t* tests, we tested whether the sample means differed significantly from the midpoint of 4.00 of the scale. Table 5 shows the sample sizes, means, standard deviations and 95% credible intervals of the IIPSS, and *t* test and Bayes statistics for each study. Only the student samples had mean values that were significantly below the neutral midpoint (*p*s ranged between <.001 and .030). The academic sample did not yield statistical significance ($p = .124$). Bayes factors further indicated that only student cohorts in Studies 1, 4, and 5 endorsed items consistent with at least moderate support of the alternative hypothesis (Quintana & Williams, 2018). Hence, students tended to prefer interdependent problem-solving, whereas responses of academics did not indicate any preference for one style over the other.

TABLE 4
Pearson correlations between the IIPSS and specific problem-solving behaviours

Variables	*Correlation with IIPSS*
(1) Asked a tutor or lecturer	−.19**
(2) Asked another student	−.30**
(3) Asked staff in the Student Hubs	−.09
(4) Asked a question on Blackboard	−.06
(5) Checked the library	.01
(6) Searched the University's website	.01

Note: $N = 337$. Two-tailed correlations. "Blackboard" is an online platform for hosting course-related material. "Student Hubs" are student support services. $^{**}p < .001$.

Gender and social class differences in problem-solving style

To test whether measurement invariance of the IIPSS scale items across gender could be assumed, we conducted a multi-group confirmatory factor analysis on the Study 1 data and partitioned the model into two groups of men and women. Compared to the unconstraint model, the changes in comparative fit indices in the models

TABLE 5
Frequentist and Bayesian one sample *t* tests indicating whether participants were more independent (*M*s > 4) or more interdependent (*M*s < 4) in Studies 1–5

								95% Credible interval	
Study No.	*N*	*M*	*SD*	*t*	*df*	*Sig.*	*BF10*	*Lower*	*Upper*
Study 1	399	3.68	1.04	−6.19	398	<.001	3,007,000	3.58	3,007,000
Study 2	186	3.85	.96	−2.19	185	.030	0.81	3.72	0.81
Study 3	198	4.11	.99	1.54	197	.124	0.23	3.97	0.23
Study 4	337	3.82	1.08	−3.04	336	.003	9.36	3.71	9.36
Study 5	235	3.62	1.01	−5.79	234	<.001	708,067	3.51	708,067

Note: BF10 = Bayes Factor 10, values >1 indicate evidence in favour of the alternative hypothesis and against the null hypothesis (H0: no preference at value of 4).

obtained by constraining measurement weights, structural covariances and error variances were .007, .007 and .012. Therefore, measurement invariance by gender could not be confirmed for measurement residuals ($\Delta > .01$). The following *t* test analysis should be viewed with caution as a result.

Consistent with self-construal theory (Cross et al., 2000), an independent samples *t* test on the aggregated data showed that mean levels of independent problem-solving were greater among men ($M = 3.97$, $SD = 1.03$) than women ($M = 3.72$, $SD = 1.03$), $t(1,344) = -4.02$, $p < .001$, $d = .22$.

An aggregate data analysis also indicated a negative relation between independent problem-solving style and social class across Studies 1, 4, and 5 ($r = -.11$, $n = 962$, $p = .002$). Hence, student participants with a higher social class reported a more interdependent problem-solving style.

Convergent and divergent validity

Personality traits

Table 6 shows the Pearson correlations between the IIPSS and personality variables.

A more independent problem-solving style was moderately and negatively associated with extraversion ($r = -.20$, $p < .001$), indicating that independent problem-solvers are less extraverted than interdependent problem-solvers. In addition, there was a moderate and negative correlation between problem-solving style and agreeableness ($r = -.21$, $p < .001$), indicating that more independent problem-solvers are less agreeable than interdependent problem-solvers. Problem-solving style was not significantly correlated with the personality traits of openness, neuroticism and conscientiousness (*r*s ranged from −.01 to .04).

As expected, problem-solving style was significantly negatively correlated with relational-interdependent self-construal ($r = -.37$, $p < .001$), which indicated that interdependent problem-solving was associated with greater relational-interdependent self-construal. Note that the size of this association does not threaten the divergent validity of the IIPSS.

Help-seeking scales

Table 6 also shows the correlations between the IIPSS and measures of help-seeking (decision-making collaboration, general help-seeking, social provisions and achievement related and help seeking tendencies). Participants' tendencies to seek help for personal problems in a suicidal crisis were negatively and significantly associated with participants' IIPSS scores (*r*s = −.53 and −.44, respectively, *p*s < .001), meaning that people with a greater interdependent problem-solving style reported greater likelihood of seeking help for personal problems. In addition, participants' willingness to collaborate in decision-making and social provisions were negatively and significantly associated with problem-solving style (*r*s = −.15 and −.32, respectively, *p*s < .001). Although formal, informal and instrumental help-seeking tendencies were also negatively and significantly related with independent problem-solving style (*r*s ranged from −.23 to −.36, *p*s < .001), help-seeking threat and help-seeking avoidance were positively and significantly correlated with independent problem-solving style (*r*s = .32 and .34, respectively, *p*s < .001), indicating that independent problem-solvers felt reluctant to seek help.

Social desirability and perceived awareness of the research hypothesis

Supporting the discriminant validity of the IIPSS, the correlation between problem-solving style and the impression management subscale of the Balanced Inventory of Desirable Responding approached zero ($r = -.02$), indicating that participants' responses to the IIPSS are not confounded with socially desirable responding. In addition, problem-solving style showed a negligible correlation with participants' perceived

TABLE 6
Pearson correlations between the IIPSS and other measures

Measure	*Correlation with IIPSS*	*N*	*Study*
Self-construal			
Relational Interdependent Self-Construal Scale	−.37**	337	4
Personality			
Extraversion	−.20**	1355	1–5
Help-seeking			
General Help-Seeking Scale		337	4
Personal problem	−.53**		
Suicidal crisis	−.44**		
Decision-Making Collaboration Scale	−.15**	337	4
Social Provisions Scale	−.32**	337	4
Achievement-related and help-seeking tendencies		337	4
Formal help-seeking	−.27**		
Informal help-seeking	−.36**		
Instrumental activities	−.23**		
Lower aspirations	.02		
Alter goals	.07		
Help-seeking scales		337	4
Formal versus informal	.05		
Instrumental	−.36**		
Executive	.02		
Help-seeking threat	.32**		
Help-seeking avoidance	.34**		
Social desirability			
IMBIDR	−.02	337	4
Demand characteristics			
Perceived awareness of research hypothesis	−.05	1157	1, 2, 4, 5

Note: Two-tailed correlations. IMBIDR = impression management subscale of the Balanced Inventory of Desirable Responding. All participants completed the IIPSS and Big Five Inventory ($N = 1355$). Participants across four studies completed the perceived awareness of research hypothesis, whereas all other measures were only administered in one sample. $^{**}p < .001$.

awareness of the research hypothesis ($r = -.05$), suggesting that the IIPSS is not confounded with demand characteristics.

Common problems experienced by participants

Because the IIPSS does not instruct participants to think about specific problems, it remained unclear which scenarios participants were thinking about when responding to the IIPSS items. To identify those problems, we included an open-ended question in Study 5 in which we asked student participants about a real-life problematic situation. When participants mentioned two interrelated problems (e.g., depressive episode because of bullying at work), we made note of both problem areas (e.g., mental health problem and work-related problem). The main problem areas that participants raised concern are balancing studies, work and social life (37%). Other problems concerned issues with academia (12%) and issues at work (10%). Interpersonal problems were also mentioned and concerned problematic situations among friends (19%), relationship partners (13%) and family members (9%). Participants further described mental health (8%) and physical health (8%) problems. Less common problem areas (< 5%) concerned hobbies, traffic, internet, security and personal growth.

DISCUSSION

This research aimed to assesses the psychometric properties of the latest version of the IIPSS. It is important to investigate the validity and reliability of this measure to establish its usefulness as a self-report tool that observes personal preferences for independent or interpersonal problem-solving in everyday problem-solving situations. We examined the factor structure, test–retest reliability, criterion-related validity, and convergent validity of the measure across four Australian university student samples and one sample comprised of international academic researchers.

Factor structure and reliability

In Study 1, the 10-item revised version of the IIPSS showed a single factor structure and good internal consistency. The single factor structure indicates that independent and interdependent problem-solving orientations constitute opposite poles of a continuum rather than two separate dimensions. The McDonald's omega coefficients of the IIPSS items were high, indicating that the revised scale items of Version 2 of the IIPSS were suitable to measure the same underlying construct. However, confirmatory factor analyses conducted across Studies 2 to 5 failed to demonstrate very good model fit for the single factor solution and instead supported the retention of a two-factor structure, whereby one factor would describe independent problem-solving and the second would describe interdependent problem-solving. Therefore, by contrasting a possible one-factor solution with a two-factor solution, the two-factor solution emerged as the superior construct. Certainly, this ambiguity reflects current knowledge based on past work that has examined the factor structure of related measures (Cross et al., 2000; Oyserman et al., 2002; Singelis, 1994; Trafimow et al., 1991; Triandis et al., 1986). Willmer and colleagues suggest that in such cases, factor analyses should be conducted each time a sample is drawn to establish the applicable sample factor structure (Willmer et al., 2019).

The test–retest reliability of the IIPSS was good but not as high as commonly seen in personality research involves measures such as the Big Five

(Gnambs, 2014). This outcome was not surprising because problem-solving style is conceptualised as a person-based tendency that remains relatively stable over time, but that can be influenced by changing life circumstances such as entering university (Rubin, 2011). Since the IIPSS is a context-free measure, we were interested to note which situations participants thought of when completing the scale items. Student participants indicated that they thought of a variety of problems, with the majority referring to conflicts between study, work and private domains. These seem to be typical issues in Australian student populations (Grimmond et al., 2020; Tolhurst & Stewart, 2004) and thus indicate that participants do not need to be prompted to think of common situations that are comparable to other members of the group. Addressing the criterion-related validity of the IIPSS, only interdependent behavioural items were related to problem-solving style. It is possible that all students engaged in the "independent" behaviours such as internet or library searches.

Correlations and problem-solving preferences

Correlations with other measures supported the construct validity of the IIPSS. In particular, interdependent problem-solving was associated with help-seeking preferences of similar scales such as the seeking social support subscale of the Ways of Coping Questionnaire (Folkman & Lazarus, 1985). Consistent with previous research (Rubin et al., 2012), a more interdependent problem-solving style was associated with extraversion. Furthermore, and as expected, problem-solving style did not vary significantly with socially desirable response patterns or demand characteristics. Interestingly, independent problem-solving preferences seems to be associated with withdrawal tendencies, such as help-seeking avoidance and help-seeking threat, whereas interdependent problem-solving preferences are associated with targeted problem-solving behaviours such as seeking instrumental activities and engaging in problem-focused coping. It is possible that some interdependent problem-solvers explore multiple ways of coming to conclusions, which includes focusing on the problem and asking others for help to overcome indecisiveness. In contrast, some independent problem-solvers may prefer to solve problems on their own because they perceive seeking help from other people as a potential source of conflict and stress.

With regards to interindividual differences in problem-solving styles, student samples expressed a small but significant preference for independent problem-solving, while academic researchers expressed more interdependent tendencies. This finding is of note because it indicates that the measure is sensitive to population preferences for problem-solving independence or interdependence across different cohorts. Given that some students move on to become researchers in the future, the noted differences could be age-related or due to generational differences. They may also reflect the more collaborative nature of academic work.

We also noted significant, albeit small, gender differences across samples. As the IIPSS was based on relational-interdependent self-construal theory, it was expected that women would prefer interdependent problem-solving more than men (Cross et al., 2000). Hardie et al. (2006) found that women preferred greater interdependent coping than men, but men and women did not differ in their use of independent coping strategies. It is therefore possible that gender differences were minimal in the current research because the IIPSS does not assess independence and interdependence separately.

Additionally, the present findings suggest that individuals with a working-class background adopt a more independent problem-solving style than middle-class individuals. This result is consistent with prior work by Bowman and colleagues who argued that middle-class Americans are socialised to make choices in more resource-rich environments (Bowman et al., 2009). Consequently, middle-class members are thought to engage in activities that maintain large social networks and to seek advice within those networks. However, these findings need to be interpreted with caution because the detected differences were relatively small in size.

Strengths and limitations

The current investigation has several strength and limitations. To our knowledge, this is the first study that has systematically examined the psychometric properties of the IIPSS, a measure that has been utilised in multiple research studies to date (Ainsworth & Oldfield, 2019; Akinbobola et al., 2018; Alexander & Beckerling, 2013; Dorgan, 2018; Sanatkar & Rubin, 2020; Seward & Harris, 2016; Vieira, 2013) with inconsistent results pertaining to its factor structure (Rubin et al., 2012; Vieira, 2013). We therefore examined the reliability and validity of the scale using several samples. In terms of limitations, it should be noted that the present research relied on self-report data and, while the samples were generally sufficiently powered for the purposes of this study, we did not design Studies 1–5 to be suitable for confirmatory factor analyses. According to Kline (2015), a "recommended sample-size-to-parameters ration would be 20:1" (p. 16). With 20 parameters in our model, each of our studies would need to have sample sizes of around $N = 400$. None of our Studies 2–5 met this criterion. Hence, the trustworthiness of our confirmatory factor analyses remains uncertain. Future research therefore should examine the factor structure of the IIPSS in sufficiently large samples

and should further address the criterion-related validity of the IIPSS considering measurement error in all analyses and with the use of objective criteria for independent and interdependent problem-solving behaviours.

A further limitation is that the study samples were unbalanced with regards to gender. Consequently, the presented analyses were unlikely to provide reliable insights into gender differences. This limitation should be addressed in future research.

Finally, the time periods of the two time points assessed to gauge test–retest reliability varied considerably between participating students (i.e., between 4 and 12 months). It is therefore not possible to provide an estimate of the measure's stability across a set period of time.

CONCLUSION

This exploratory investigation of Version 2 of the IIPSS to assess independent and interdependent problem-solving in non-specific contexts demonstrated its utility. Additional research should address the ongoing ambiguity concerning the factor structure and the shortcomings of the present study, particularly as it pertains to objective and longitudinal assessments. Future work should further assess problem-solving preferences in collectivistic cultures and establish the socio-psychological consequences of independent and interdependent problem-solving (Sanatkar & Rubin, 2020), particularly with regards to barriers to help seeking.

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