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Bayesian Confirmatory Factor Analysis of the Psychological Capital PCQ-12 Scale

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Abstract

Psychological Capital (PsyCap) is a key construct in psychological research across the life span. Despite the PCQ-12 is among the most used scales to approach its measurement, its factor structure and reliability remain controversial, and in particular, in adolescents' samples. Data came from a cross-sectional survey administered to 267 Spanish adolescents, 59.9% girls (mean age 13.96, SD= 1.56). Confirmatory Factor Analyses (CFAs) in Mplus 8.6 were used to compare three competitive models (one factor, four correlated factors, and a second order structure) estimated with Bayesian methods. Although Efficacy, Hope and Optimism significantly explained their indicators, and their cross-loadings were not statistically significant, Resilience operated differently. We obtained evidence supporting the second order structure. Also, it come clear, the scale has difficulties in measuring Resilience in adolescents. Consequently, further research should explore new adaptations or alternative measures to overcome these limitations when researching in adolescents.

Keywords: psychological capital, psychometric properties, adolescence, Bayesian CFA

Introduction

Psychological Capital (PsyCap) emerged as a key construct in the organizational literature (Avey et al., 2011), but its relevance across fields is evident (Siu et al., 2021). PsyCap is “an individual’s positive psychological state of development and is characterized by (1) having confidence (Self-Efficacy) to take on and put in the necessary effort to succeed at challenging tasks; (2) making a positive attribution (Optimism) about succeeding now and in the future; (3) persevering toward goals and, when necessary, redirecting paths to goals (Hope) in order to succeed; and (4) when beset by problems and adversity, sustaining and bouncing back and even beyond (Resilience) to attain success” (Luthans et al., 2015, p. 2). Its study in school-age youth is growing during the last years (Preston et al., 2021). It has been shown to promote subjective well-being (e.g. Datu & Valdez, 2016) or academic performance (e.g. Carmona-Halty et al., 2018; Datu et al., 2018), while reducing anxious and depressive symptoms (e.g. Finch et al., 2020).

The most used PsyCap scales are the 24-item PsyCap Questionnaire (PCQ-24; Luthans et al., 2007), and its brief version, the 12-items Psychological Capital Questionnaire (PCQ-12; Avey et al., 2011). There are alternatives as the Compound PsyCap scale (CPC-12, Lorenz et al., 2016) or an adapted version of the PCQ-12 (Djourova et al., 2019). The PCQ-12 has been adapted to the academic context (Martínez et al., 2021; Schönfeld & Mesurado, 2020) and also new scales have been developed specifically for students partially based on the PCQ-12 (King & Caleon, 2021).

Despite its use, factor structure and reliability of PCQ-12 remain controversial (Dawkins et al., 2013; Djourova et al., 2019). Regarding its factorial structure, the original authors proposed a hierarchical structure with four first-order factors (Self-efficacy, Hope, Resilience, and Optimism) and one second-order one (PsyCap) (Avey et al., 2011). However,

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some studies found that a four-factor structure fits better than the second-order model (e.g. López-Núñez et al., 2018; Santana-Cárdenas et al., 2018; Viseu et al., 2012). This controversy seems to appear, largely, in the adaptations of the scale in Portugal and Spain, which could indicate an effect related to the context or translation (Djourova et al., 2019). Regarding its reliability, some studies showed problems in some dimensions: in Resilience ($\alpha=.5$) and Optimism ($\alpha=.64$) (López-Núñez et al., 2018); and also in resilience (Santana-Cárdenas, 2018; Viseu et al., 2012).

In adolescents' samples, to date two validations of the PCQ-12 have been carried out, and both showed some psychometric problems. Martínez et al. (2021) found in Spanish and Chilean samples alphas of .59 and .68, respectively, for Resilience, and .62 for Optimism in the Spanish sample. Besides, the initial second order structure only fitted the data well after covariances among residuals were included. Furthermore, the second-order structure was not compared with the alternative four-factor structure. Schönfeld and Mesurado (2020) tested the scale in Argentinian adolescents with good reliability results but they tested a four-factor model without comparing it with the second-order model initially proposed in the literature. The fact that previous validations in adolescent samples tested different factor structures without comparing alternative models evidences the lack of consensus in the field.

As the PsyCap research is receiving attention in recent years and the PCQ-12 is used frequently (Martínez et al., 2019; Siu et al., 2021), it is essential to guarantee its adequate psychometric properties. The PCQ-12 offers a shorter alternative to the PCQ-24 for studies where there are time constraints. This advantage justifies the need to explore its psychometric properties and work to improve them. This study aims to deepen the study of the PCQ-12 in academic contexts studying its factor structure and reliability.

Method

Participants

Several private and public high schools were contacted to distribute an online questionnaire among their students. Participation was completely voluntary and non-rewarded. Participants were 267 adolescents from Valencia (Spain), with mean age 13.96 (SD= 1.56). Ages ranged from 9 to 17 years. In terms of age categories: 22.7% in the range 9-12; 35.4% between 13-14; and 41.9% between 15-17. 59.9% were females. 141 students came from public high schools (52.8%), whereas 116 study in private ones (43.4%). For a CFA model with 12 indicators, four latent variables, power of .8, alpha of .05 and an effect size of .4, the sample size calculator expected a minimum sample size of 200 (Soper, 2021).

Instruments

Psychological Capital was measured with the Spanish version of the PCQ-12 (León-Pérez et al., 2017) adapted to academic contexts with students' samples (v. gr. Luthans et al., 2014; Martínez et al., 2021). The adaptation consists of changing references to “work” to “school-work” or “studies”. It has four dimensions: Self-efficacy (three items), Hope (four items), Resilience (three items), and Optimism (two items). The response format was from *strongly disagree* (1) to *strongly agree* (5).

Procedure

Data collection was conducted online using SurveyMonkey between January and February 2021. The research met APA's ethical standards and it was approved by the Ethical Commission of the ##### (#####CODE#####). Participation in the study was voluntary and anonymous. Prior to the start of the survey, families and participants signed an informed consent.

Data analysis

Confirmatory Factor Analyses (CFAs) were conducted to compare competitive structures in Mplus 8.7 (Muthén & Muthén, 1998-2017), and were estimated with Bayesian estimation. Model fit was assessed with: Posterior Predicted p-value (PPp), Bayesian Comparative Fit Index (BCFI), Bayesian Root Mean Square Error of Approximation (BRMSEA), and Deviance Information Criterion (DIC). In order to assess model fit, we have considered values larger than .95 for the CFI and lower than .08 for the RMSEA (Asparouhov & Muthén, 2021; Hu & Bentler, 1999). For model comparison, BCFI differences of less than .01 are considered negligible (Cheung & Rensvold, 2002), and lower values of DIC are considered indicative of better relative fit. Two independent Markov Chain Monte Carlo (MCMC) chains were used for BCFA (Asparouhov et al., 2015), with a minimum of 200000 iterations, and thin=4. Muthén and Asparouhov (2012) proposed a new statistical approach, BCFA with near-zero cross-loadings. This approach allows simultaneous estimation of all cross-loadings by using approximate near-zero informative priors to replace the exact zeros for the cross-loadings. Two set of priors were used for BCFA: diffuse priors without cross-loadings (i.e., cross-loadings were fixed to exact zero); and BCFA with informative priors for all cross-loadings. These informative priors were normal with mean hyperparameter set to zero and a small variance hyperparameter of 0.01, which yields cross-loading bounds of ± 0.20 (Muthén & Asparouhov, 2012). Additionally, a sensitivity analysis on priors was made by testing multiple variance hyperparameters: .001, .005, .01, and .05. This sensitivity analyses reinforced the use of .01 as the variance hyperparameter. Model convergence was monitored by potential scale reduction (< 1.10 suggesting convergence), checking of trace and autocorrelation plots and calculation of effective sample size.

Results

Four a-priori factors structures were tested: one factor, four correlated factors, a second order model, and a bifactor structure. The four-factor and the second order models were also estimated with BCFA with near-zero cross-loadings. Therefore, six CFAs were finally tested.

Goodness-of-fit indices are shown in Table 1. The one-factor structure did not reach a reasonable fit. The four correlated factors, the second order model and the bifactor model had very good model fit. The inclusion of near-zero prior cross-loading lead best fit (cross loadings exactly zero are not tenable). The best fitting models were the second order model and the bifactor. However, fit differences were negligible between these two models, the BCFI differences was .009 (less than .01) and the DIC differences were only 1.6. Therefore, the most parsimonious second order model was retained.

Table 1. Fit indices and statistics for the estimated models

Model	PPp	DIC	BRMSEA [CI 90%]	BCFI [CI 90%]
<i>One factor</i>	<.01	8343.3	.129 [.125, .133]	.734 [.715, .750]
<i>Four factors</i>	.012	8170.5	.059 [.047, .073]	.952 [.929, .970]
<i>Four factors near-zero priors</i>	.142	8153.8	.044 [.000, .065]	.974 [.943, 1.00]
<i>Second order</i>	.009	8165.3	.056 [.046, .067]	.952 [.931, .968]
<i>Second order near-zero priors</i>	.121	8147.2	.041 [.018, .057]	.975 [.951, .995]
<i>Bifactor model</i>	.217	8145.6	.035 [.000, .054]	.984 [.962, 1.00]

Note: PPp= Posterior Predictive p-value, DIC= Deviance Information Criterion, BRMSEA Bayesian RMSEA, BCFI= Bayesian CFI, CI= Credibility Interval.

Table 2 offers the standardized factor loadings for the best fitting model (second order model with near zero priors). While Self-Efficacy, Hope and Optimism significantly explained their indicators, and their cross-loadings were not statistically significant, Resilience operated differently. Cross-loadings with other factors were also statistically non-significant but its own indicators were not significantly related to Resilience, except for one item in the second order model. The best fitting model is the second order BCFA with near

zero priors. Additionally, second-order standardized loadings for Self-efficacy, Hope,

Resilience and Optimism were, respectively: .549, .876, .889, and .788.

Table 2. Standardized factor loadings for the best fitting model, the second order model: Bayesian second order model with near-zero cross-loadings in the second column. Notes: * = 95% credible interval (CI) did not include 0, cross loadings in italics.

Item	Self-Efficacy	Hope	Resilience	Optimism
1 Self-Efficacy 1	.699*	.030	.018	.013
2 Self-Efficacy 2	.940*	-.029	-.010	-.002
3 Self-Efficacy 3	.673*	-.015	.025	.041
4 Hope 1	-.055	.486*	.044	.075
5 Hope 2	-.010	.832*	-.007	.037
6 Hope 3	-.013	.544*	.026	.078
7 Hope 4	-.005	.774*	-.006	.022
8 Resilience 1	.013	.024	.654*	.033
9 Resilience 2	.069	-.002	.208	.018
10 Resilience 3	.075	-.011	.126	.014
11 Optimism 1	.054	-.002	-.015	.621*
12 Optimism 2	.023	.011	.002	.648*

These results are reinforced when Composite Reliability Indexes (CRIs) are computed for the four factors based on the loadings of their indicators. CRIs are adequate for Self-Efficacy (.82) and Hope (.76), but not for Optimism (.57) and especially for Resilience (.28). This result shows that the amount of shared variance in the Resilience factor is, for this sample, almost irrelevant.

Discussion

Psychological capital (PsyCap) is an important construct that has been related to many different outcomes in psychological research. Some researchers have shown its usefulness in the academic field by showing its relationship with academic performance (Luthans et al., 2019; Martínez et al., 2019). Therefore, its adequate measurement in populations of students is a non-trivial task. In this vein, this research provides psychometric evidence, from a Bayesian approach, for the PCQ-12 in academic contexts.

While the original development and validation found a second-order structure for the scale (Avey et al., 2011), most studies reported evidence for a four-correlated-factor structure (López-Núñez et al., 2018; Santana-Cárdenas et al., 2018; Viseu et al., 2012). This research has tested four alternative models: one factor, four factors, a second-order factor, and a bifactor model. To our knowledge, our research is the first one that explores the possibility of a bifactor structure. Among them, the second-order model and the bifactor showed the best fit to the data. For the sake of parsimony, the second-order model is retained. These results support the original factor structure proposed by the authors (Avey et al., 2011) and some previous research (e.g. León-Pérez et al., 2017; Kamei et al., 2018).

Although the overall model fit of the scale is adequate, this scale has important psychometric problems, specifically in the measure of Resilience. Reliability results of our research show that, with a sample of this age, the valid measurement of Optimism and especially Resilience is jeopardized, which is in line with other results found in the Spanish-speaking context (Martínez et al, 2021; Schönfeld & Mesurado, 2020). The indicators of Resilience in the PsyCap scale simply do not share enough common variance and the measuring of this dimension of PsyCap is poor. Resilience items came from the Resilience Scale (Wagnild & Young, 1993), a 25-item scale that has been considered the best option to study resilience in the adolescent population (Ahern et al., 2006). However, the items included in the PCQ-12 were chosen based on the psychometric results of the PCQ-24 in a sample of 106 engineers (Avey et al., 2011), retaining those items with higher factor loadings, and better contribution to internal reliability and construct validity. This procedure, based on a small non-representative sample, could not guarantee the adequacy of the item selection in other samples.

The Resilience item with the worst performance in the factor was Item 10 (“I can get through difficult times at school because I’ve experienced difficulty before”). The same item

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showed a factor loading under .3 in a Spanish adaptation (Léon-Pérez et al., 2017). Item wording could be complex to understand and difficult to answer for adolescents because it is asking for the co-occurrence of two facts: (1) “I can get through difficult times at school” and (2) “I’ve experienced difficulty times”, and the second fact led me to the first one. Younger students could have not experienced difficult times, and still believe in their ability to succeed in the future. However, the reliability problems in the Resilience factor were not always related to this item in previous literature. Some studies have also found problems with item 9 (Martínez et al., 2021; Santana-Cárdenas et al., 2018).

Reliability problems in Optimism and Resilience are a common problem in PCQ-12 validations in Spanish and Portuguese translations (López-Núñez et al., 2018; Santana-Cárdenas et al., 2018; Viseu et al., 2012). However, several previous studies using the PCQ-12 in not Spanish-speaking context just inform the reliability for the global PsyCap and do not report the reliability of its dimensions. For example, in Dawkins et al.’s (2013) review, no studies included using the PCQ-12 reported reliability for the dimensions. It is noteworthy that the study that originally proposed the PCQ-12 does not inform about the reliability of Optimism or Resilience (Avey et al., 2011). Consequently, although the reliability problems could be related to cross-cultural factors and translations, we need further research also in English-speaking countries. A potential solution could be a revision of the items included in these dimensions considering wider representative samples or an increment in items.

Our study presents some limitations. First, it has been developed with a Spanish sample of students, which could compromise the generalizability of the results. Second, as a psychometric evaluation of the scale, this study lacks the consideration of nomological validity. This research was mainly focused on the factorial structure; complementary validity evidence is needed.

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In conclusion, our study roughly confirmed the theoretically proposed second-order structure and highlighted the reliability problems of some of its dimensions. We ask researchers to improve the scale adaptation process or explore alternative measures developed specifically in academic contexts for Resilience (King & Caleon, 2021). Additionally, it could be good advice to include more indicators of Optimism (Djourova et al., 2019).

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Open Science

We report how we determined our sample size, all data exclusions (if any), all data inclusion/exclusion criteria, whether inclusion/exclusion criteria were established prior to data analysis, all measures in the study, and all analyses including all tested models. If we use inferential tests, we report exact p values, effect sizes, and 95% confidence or credible intervals.

Open Data: The information needed to reproduce all of the reported results is available in https://osf.io/f74k8/?view_only=41c8fedde2fe43188ad7211b51020cb8.

Open Materials: I confirm that there is sufficient information for an independent researcher to reproduce all of the reported methodology.

Preregistration of Studies and Analysis Plans: This study was not preregistered.