

Cuestionario Honey-Alonso de Estilos de Aprendizaje: Nuevas evidencias psicométricas en población argentina

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Resumen

En el presente trabajo se examinan las propiedades psicométricas de la versión argentina del Cuestionario Honey-Alonso de Estilos de Aprendizaje (CHAEA). Primero se analiza la estructura interna de la escala mediante un análisis factorial confirmatorio y de invarianza factorial, segmentando la muestra según facultad; luego se estudia la consistencia interna de las dimensiones confirmadas y se comparan los resultados con los obtenidos en estudios previos; posteriormente se examina la estabilidad temporal de las puntuaciones de cada dimensión; y, por último, se estudian las evidencias de validez concurrente con otra escala que evalúa enfoques de aprendizaje. Los resultados del análisis factorial confirmatorio muestran un adecuado ajuste del modelo testeado a partir de distintos métodos de estimación, mientras que con el análisis de invarianza factorial se comprueba la equivalencia métrica del modelo. Asimismo, los índices de consistencia interna son aceptables, aunque el análisis de estabilidad temporal de las dimensiones no comprueba diferencias significativas entre la primera y segunda administración del instrumento. Finalmente, en consonancia con hallazgos previos, las evidencias de validez concurrente exhiben asociaciones positivas entre los estilos de aprendizaje y el enfoque profundo, así como asociaciones negativas entre los estilos y el enfoque superficial. Al final se discuten los resultados a partir de antecedentes teóricos y empíricos.

Palabras clave: estilos de aprendizaje, CHAEA, validez, consistencia interna, estabilidad temporal, estudiantes universitarios.

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Honey-Alonso Learning Styles Questionnaire: New psychometric evidences in Argentinean population

Abstract

The study is aimed at analyzing psychometric features of the local version of the Honey-Alonso Learning Styles Questionnaire. First, the inner structure of the scale is examined by means of a confirmatory factor analysis and an analysis of factorial invariance, splitting the sample by faculty. Second, internal consistency coefficients of the dimensions are analyzed and compared to previous results. Third, external convergent validity evidences are considered, regarding scores obtained from a learning approach scale which was used as an external criterion. Findings show an adequate model fit, even employing different estimation methods. Furthermore, the factorial invariance analysis verifies the metrical equivalence of the model. The internal consistency study finds acceptable values. The dimensions' stability reliability indices do not verify significant differences between test and retest. Finally, the convergent validity evidences analyses show positive associations between learning styles and the Deep learning approach on the one hand, and negative associations between the Surface approach and learning styles on the other, as reported in previous studies. Results are discussed on the grounds of the theoretical and empirical background.

Keywords: learning styles, CHAEA, validity, internal consistency, stability reliability, college students.

Introduction

Learning styles is a concept referred to cognitive, emotional and physiological features used by students when they must deal with learning situations (Keefe, 1982). The notion is aimed at describing individual differences indirectly linked to academic achievement (Jiraporncharoen, Angkurawaranon, Chockjamsai, Deesomchok, & Euathrongchit, 2015; Mozaffari et al., 2020; Wilkinson, Booahan, & Stevenson, 2014). Thus, assessing learning styles leads to adapt teaching methods in order to make them suitable for each student's singularity when improving teaching-learning results matters (Gutiérrez-Tapias, 2018).

Several studies showed interest in the analysis of learning styles (e.g. Biabani & Izadpanah, 2019; Cea-Rodríguez, Sanhueza-Burgos, & Filgueira-Muñoz, 2018; Halili, Sulaiman, Sulaiman, & Razak, 2019; Olanipekun et al., 2020) whilst a number of scales to measure them in college students were developed (e.g., Alonso, Gallego & Honey, 1994; Dunn, Dunn, & Price, 1982; Grasha & Riechmann, 1975; Honey & Mumford, 1986; Jackson, 2002; Kolb, 1976; Myers & Myers, 1980; Renzulli & Smith, 1978; Rezler & Rezmovic, 1974; Schmeck, Ribich, & Ramanaiah, 1977; Vermunt, 1998; Witkin, Oltman, Raskin, & Karp, 1971).

As for versions in Spanish, the Honey-Alonso Learning Styles Questionnaire (CHAEA; Alonso et al., 1994) is broadly employed, not only by practitioners but also by

researchers (Escanero-Marcén, Soria, Guerra-Sánchez, & Silva, 2016; Juárez-Lugo, Rodríguez-Hernández, & Luna-Montijo, 2012). The CHAEA version adapted to be used with local college students assesses four learning styles (Freiberg-Hoffmann & Fernández-Liporace, 2013). Only one of them –*Pragmatist*– corresponds to Alonso's theoretical model (Alonso et al., 1994) whilst the remaining three –*Assimilating*, *Accommodating*, and *Converging*– are related to Kolb's model (Kolb, 1976).

Students with an *Assimilating* style show good abstraction skills, therefore being able to understand information of diverse nature. Besides, they can explain it to other persons simply and clearly. They are more focused on the value of theoretical ideas rather than on their practical use. Regarding learning, they prefer reading, profound comprehension and theoretical models' comparisons (Kolb & Kolb, 2005).

Accommodating students feel at ease when they apply theoretical notions to work in the field. They use intuition more than reflection in view of their interest in new and challenging activities. They achieve a higher quality learning based on their daily life experience. They also prefer setting goals and collaborative work (Kolb, 1984).

Converging individuals stand out when they imagine different practical uses for the same idea. They are enthusiastic when problem-solving is the challenge. They enjoy integrating new ideas, conducting laboratory trials, simulations and all sorts of activities feasible to be applied to real problems furtherly (Kolb & Kolb, 2005).

Pragmatists are proficient at conceptual analysis, and at identifying which concepts are likely to be applied successfully in daily life. Since they are self-confident, they are impatient to test their own ideas as soon as possible. They feel thrilled when examining the practical usefulness of concepts. However, they can focus on planning steps to achieve learning, such as goal settings, time management and readings (Alonso et al., 1994).

CHAEA is habitually employed to describe individual students' profiles and group profiles. It is also useful in the analysis on how these four learning styles are linked to academic achievement. Moreover, it leads to examine differences among students attending different majors or different stages in their academic pathways. Hence, it is useful as an assessment resource to be used in college (Altamirano-Droguett, Araya-Crisóstomo, & Paz-Contreras, 2019; Cardozo, Molano-Sotelo, Moreno-Jiménez, Vera-Rivera, Peña-Vega, 2018; Escanero-Marcén, Soria, Guerra-Sánchez, 2018; Freiberg-Hoffmann, Berenguer, Fernández-Liporace, & Ledesma, 2017; Ponce-Cumbreras & Gamarra-Bustillos, 2015; Prieto-Loureiro, 2019; Rodríguez, Limón, Pisfil, Torres, & Exume, 2015; Villalba, 2015).

In spite of the fact that CHAEA is extensively used, evidences on its internal structure are still controversial, and the replication of the factorial solution hypothesized by the original authors is still a matter of debate (Lopes da Silveira, 2013; Orellana, Bo, Belloch, & Aliaga, 2002; Rodríguez-Gómez, 2006; Silva-Falchetti, 2009). Moreover, even though the CHAEA's local adaptation achieved an adequate fit of the confirmed 4-factor underlying model with acceptable internal consistency indices - adequate for the number of items retained in each dimension- (Freiberg-Hoffmann & Fernández-Liporace, 2013), these factors are rather different from the ones hypothesized by Alonso et al. (1994). In view of the discrepancies between the theoretical dimensions and the ones reported in different studies, the analysis of CHAEA's internal structure remains as a research issue.

Taking the findings formerly described into consideration, the present study is aimed at analyzing new validity evidences and reliability results in local college students. They will be added to the ones previously examined (Freiberg-Hoffmann & Fernández-Liporace, 2013). To do so, three steps are developed: 1) analyzing the CHAEA's internal structure -confirmatory factor analysis, factorial invariance and internal consistency-, 2) examining the scores stability reliability, and 3) analyzing convergent validity evidences between learning styles and leaning approaches.

Method

Design

A psychometric and cross-sectional study was conducted.

Participants

A convenience sampling was employed.

CHAEA internal structure analysis: The sample included 1342 college students from Buenos Aires (43.7% males, 56.3% females) attending different faculties (31.8%, Psychology; 25.1%, Natural Sciences and Math; 21.4%, Engineering; 11.9%, Medicine; 9.8%, Philosophy), with ages between 17 and 36 years old ($M_{age} = 23.32$; $SD = 2.82$).

Test-retest stability reliability study: The sample was composed of 20 Psychology students (20% males, 80% females) aged between 21 and 36 years old ($M_{age} = 24.85$; $SD = 4.17$).

Convergent validity evidences analysis: The sample was made up of 789 college students from Buenos Aires (48.7% males, 51.3% females) aged between 17 and 36 years old ($M_{age} = 22.96$; $SD = 3.68$), who were attending different faculties (40.6%, Psychology; 27.9%, Engineering; 15.2% Natural Sciences and Math; 8.9% Law and 7.5% Medicine).

Instruments

Honey-Alonso Learning Styles Questionnaire

The local version for college students, previously described in the introduction, was employed (Freiberg-Hoffmann & Fernández-Liporace, 2013). It comprises 28 items with a dichotomous response. They assess the *Assimilating*, *Converging*, *Accommodating*, and *Pragmatist* styles.

Revised Two Factor Study Process Questionnaire (R-SPQ-2F) (Biggs, Kember, & Leung, 2001)

It measures learning approaches, which are defined as the motives and strategies depending on the educational context, which students employ to process information in learning situations (Biggs, 1988). Specifically, R-SPQ-2F assesses two types of learning approaches: Deep approach and Surface approach. On the one hand, the first one corresponds to persons interested in understanding contents in order to integrate them with previous knowledge. On the other hand, the second approach is common to students who show no interest in learning. They prefer learning by heart and recalling without a genuine comprehension. The Deep approach is positively associated with academic

achievement whilst the Surface approach obtained a negative index (Biggs & Tang, 2011). This study employed the version adapted to be used with college students from Buenos Aires (Freiberg-Hoffmann & Fernández-Liporace, 2016). It is composed of 20 statements responded by a Likert scale indicating the degree of agreement of the examinee with each assertion. Such version obtained adequate internal consistency indices for its dimensions (ordinal alphas > .80), appropriate construct validity evidences -principal components and confirmatory factor analysis-, as well as content and face validity evidences -experts review and pilot study-. In order to add new psychometric evidences to the ones previously reported, the present study conducted a confirmatory factor analysis, which verified the model fit to empirical data. Such procedure found adequate fit indices CFI (.932), NFI (.915), NNFI (.924), and RMSEA (.066). Internal consistency was also examined in a further step, obtaining adequate ordinal alpha coefficients for the Deep (.755) and Surface approaches (.839). Additionally, information about gender, age and faculty was collected.

Procedure

A trained psychologist gathered data during classes. Students were informed about the voluntary nature of participation whilst anonymity and confidentiality were guaranteed. They were also told about the possibility of ceasing their responses at any point of the procedure. Examinees signed an informed consent where the former conditions were accepted. The research goals were also included in that form.

Data analysis:

CHAEA's internal structure analysis: LISREL 8.8. software was used. As a first step, the assumption of multivariate normality of the variables into analysis was tested. Since such hypothesis was not verified, robust estimation methods were employed (Holgado-Tello, Morata-Ramírez, & Barbero-García, 2018). Thus, tetrachoric correlation matrices and the weighted least squares estimation methods (WLS) were calculated. In addition, such calculations replicated the procedures that were previously followed in the study by Freiberg-Hoffmann and Fernández-Liporace (2013). Furthermore, other estimation methods were calculated -diagonally weighted least squares (DWLS) and robust unweighted least squares (RULS)-. In other words, using multiple methods guaranteed the independence of results. The model fit and parsimony were tested by means of the same indices used in the former study in order to compare results. Goodness of Fit Index (GFI), Adjusted Goodness of

Fit Index (AGFI), Root Mean Square Error of Approximation (RMSEA), Parsimony Goodness of Fit Index (PGFI), and Parsimony Normed Fit Index (PNFI) were calculated.

To examine the factorial invariance, the variable *faculty* was selected to test the metric equivalence of the scale across samples of students attending different faculties. Several nested models were tested, imposing different restriction levels: first, a configural model, with no restrictions -Model 1-, second, a metric model restricting regression coefficients -Model 2-, third, a structural model restricting covariances -Model 3-. The robust unweighted least squares estimation method (RULS) was used. It is advisable for categorical variables and small samples since it leads to the reduction of Type I error, as well as to increase the statistical power of the analyses (Holgado-Tello et al., 2018). The invariance was interpreted by the CFI and RMSEA indices, suggested to analyze categorical variables and multiple samples with different sizes (Chen, 2007; Rojas, Rojas, & Brizuela, 2018).

To analyze the dimensions' internal consistency, *KR-20* indices were estimated. They were compared -current study versus previous study- by means of the Kendall's *W* concordance coefficient (Feldt, 1969).

Stability reliability test-retest study: The SPSS 21 software package was employed. First, the normality assumption was analyzed and verified. Stability reliability of the dimensions' scores was examined by a test-retest procedure, with a 30-day interval -paired samples Student's *t* test-. The association between the pre-test and post-test scores was also analyzed, using the intra-class correlation coefficient (*ICC*).

Convergent validity evidences analysis: SPSS 21 was employed to test the data normality assumption, which was not verified. Thus, a non-parametric test was the choice. Then, Spearman's *rho* correlation coefficients between the CHAEA styles and the R-SPQ-2F's approaches were calculated.

Results

CHAEA's internal structure study

Confirmatory factor analysis

In order to test whether the factorial model confirmed in a local sample (Freiberg-Hoffmann & Fernández-Liporace, 2013) was also confirmed in a new local sample, a confirmatory factor analysis was conducted (Fig. 1).

Every tested model obtained an adequate fit, even using different estimation methods (Table 1).

Table 1
CHAEA. Model fit indices

	Fit Indices					Parsimony Indices	
	χ^2	df	GFI	AGFI	RMSEA[IC]*	PGFI	PNFI
Former study (Freiberg-Hoffmann & Fernández-Liporace, 2013) (WLS)	1668.341**	344	.934	.922	.075 [.071-.078]	.792	.669
Current study (WLS)	2126.880**	344	.960	.953	.064 [.059-.064]	.814	.790
Current study (DWLS)	9841.310**	344	.949	.939	.055 [.053-.058]	.804	.882
Current study (RULS)	10011.903**	344	.919	.904	.055 [.052-.057]	.779	.882

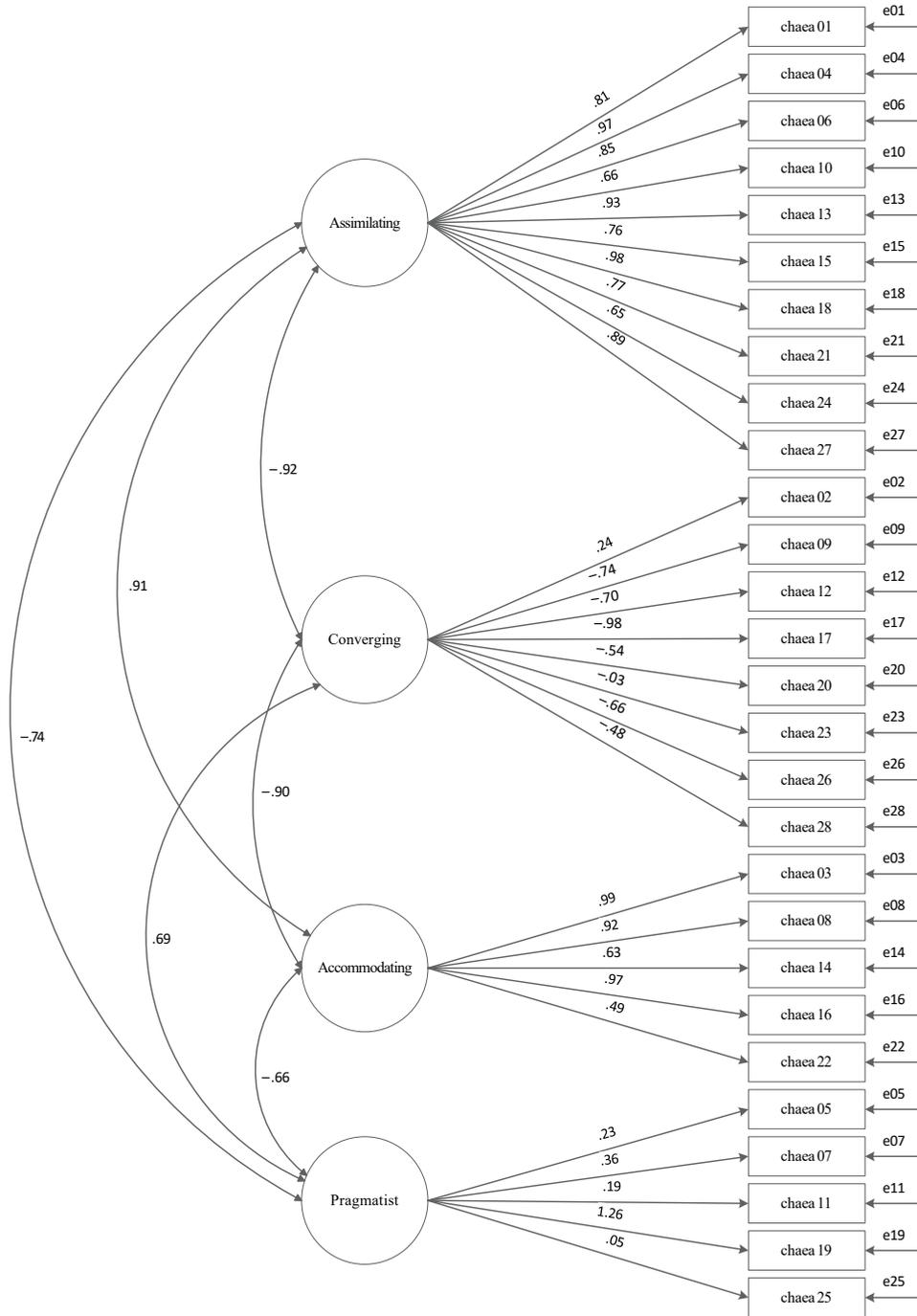


Figure 1. CHAEA. 4-factor model. WLS estimation method.

Table 2
CHAEA. Internal consistency indices comparison

	Assimilating	Converging	Accommodating	Pragmatist
Former study (Freiberg-Hoffmann & Fernández-Liporace, 2013) (KR-20)	.65	.63	.62	.50
Current study (KR-20)	.70	.60	.72	.49
W _(KR-20, Actual - KR-20, 2013)	.85	.92	.73	.98
P _(KR-20, Actual - KR-20, 2013)	.01	.12	.00	.38

Internal consistency analysis

The internal consistency analysis of the dimensions obtained adequate KR-20 coefficients for every dimension. In addition, the comparison between indices obtained in both local studies -previous versus current-, found significant differences ($p < .05$) for the *Assimilating* and *Accommodating* styles (Table 2).

Factorial invariance analysis

The model's factorial invariance was examined applying different restriction levels. The model invariance was verified (Table 3).

Table 3.
CHAEA, Factorial invariance across faculties

	RMSEA [IC 90%]	ΔRMSEA	CFI	Δ CFI
Configural	.061 [.058-.064]	-	.969	-
Metric	.061 [.058-.063]	.000	.967	.002
Structural	.061 [.058-.063]	.000	.967	.002

Note. ** $p < .01$

Stability reliability study (test-retest)

The scale's dimensions stability and reliability were analyzed, comparing scores obtained from two repeated measures. Significant differences were not verified (Table 4).

Table 4
CHAEA. Scores' stability reliability for dimensions

Dimension	ICC	t	df	p
Assimilating	.783**	1.453	19	.163
Converging	.850**	-6.79	19	.505
Accommodating	.834**	-9.00	19	.379
Pragmatist	.507*	.777	19	.447

Note. ** $p < .01$; * $p < .05$

Table 5.
CHAEA. Convergent validity evidences with R-SPQ-2F

Learning Approaches	Learning Styles			
	Assimilating	Converging	Accommodating	Pragmatist
Deep	.294**	.354**	.183**	.317**
Surface	-.180**	-.304**	-.066	-.186**

Note: ** $p < .01$

Convergent validity evidences study

Correlation coefficients calculated between learning styles scores (CHAEA) and learning approaches (R-SPQ-2F) were all significant, except for the one concerning Accommodating style and Surface approach (Table 5).

Discussion

The present study analyzed new psychometric features of the CHAEA's local version, adapted to be used with Argentinean college students. Such new evidences will be added to and compared with the ones obtained in a previous local study, developed on the same population (Freiberg-Hoffmann & Fernández-Liporace, 2013). To do so, a confirmatory factor analysis and an internal consistency study were conducted. New construct validity evidences -factorial invariance-, criterion validity evidences -convergent validity evidences-, and stability reliability of scores were also examined. As for professionals in the assessment field, the study is intended to report new findings about the scale's technical quality, in order to encourage them to use it with confidence in their practice. From a conceptual standpoint, it is aimed at analyzing in depth and amplifying studies on the internal structure of the scale, which still remains as an object of debate.

First, the internal structure of CHAEA verified an adequate fit of the theoretical model to data. Fit indices, obtained by means of all the recommended methods for categorical variables -WLS, DWLS y RULS- (Kořar & Kořar, 2015), were similar to the ones reported in a previous study conducted on the same population (Freiberg-Hoffmann & Fernández-Liporace, 2013). All indices reached the suggested values, higher than .90 -GFI and AGFI-, and lower

than .08 for RMSEA (Schumacker & Lomax, 2016). Such results confirmed the model despite the fact that each one of the methods employed usually obtain biased estimations due to different issues -sample size, number of observed and latent variables, number of parameters to be estimated, number of response options, etc.- (Li, 2015). Hence, the hypothesis stating that the internal structure of the scale is not significantly affected by the standard error seems reasonable. This implies a better estimation of the true scores.

Furthermore, the fitness of the model, estimated by means of the WLS method, is higher than the one reported in the former local study, where the same method was used (Freiberg-Hoffmann & Fernández-Liporace, 2013). Since the robustness of the estimations obtained by the WLS method mainly depends on the sample size, such difference is likely to be found (Holgado-Tello et al., 2018; Jackson, Gillaspay, & Purc-Stephenson, 2009). Therefore, it is reasonable to expect that the current study ($N = 1342$), whose sample size duplicates the one used in the former study ($N = 682$), would find, by reducing the Type I error, higher fit indices. This justifies the fit difference between the models compared in both opportunities, interpreting results as equivalent. Regarding the estimated parameters, even when some negative values were observed, leaving aside any special statistical treatment of data appeared to be the best decision. Such decision was made since negative values are expected when dealing with tetrachoric correlation matrices, free asymptotic estimation methods and heterogeneous samples (Yuan, Wu, & Bentler, 2011). Furthermore, the presence of this type of improper solutions has no significant effect on statistical indices such as *chi-square* (Chen, Bollen, Paxton, Curran, & Kirby, 2001).

Second, when comparing the *KR-20* internal consistency indices found in the current study and the previous one (Freiberg-Hoffmann & Fernández-Liporace, 2013), differences between the *Accommodating* and *Assimilating* styles scores emerged. However, it is important to consider that such coefficients depend on the sample size, increasing their value when more participants are added (Feldt, Woodruff, & Salih, 1987). Therefore, it seems reasonable to infer that the differences found in favor of the present study would be attributable to the larger sample size rather than to real differences in the observed scores.

Third, regarding the factorial invariance across faculties, the present study verified the equivalence of CHAEA's internal structure. This implies that the scale remains unaltered across different samples of students attending different faculties. Consequently, there is favorable evidence for the generalization of the model. In other words, CHAEA's

scores are less likely to be influenced by measurement bias (Jak, 2014).

Fourth, also regarding the CHAEA internal structure analysis, the adequate parsimony of the model is worth mentioning. RMSEA indices were lower than .08, AGFI higher than .90, whilst PNFI, and PGFI were higher than .50 for every estimated model (Brown, 2015; Hahs-Vaughn, 2017; Mulaik, 1989). This means that CHAEA assesses learning styles -*Assimilating*, *Converging*, *Accommodating*, *Pragmatist*- in a way that they keep an adequate representativeness regarding the construct without losing explanatory capacity.

Fifth, the scores stability reliability exam shows that they remain stable for 30 days ($p > .01$). It means that the sources of error that undergo temporary changes -learning, mood, physical state, among others- would not affect the measurements derived from the instrument during that interval (Irwin & Hughes, 2018).

Sixth, as for convergent validity evidences, every learning style is positively associated with the Deep approach, and negatively with the Surface one. The unique exception is the non-correlation between Surface approach and the *Accommodating* style. However, such style correlates positively with the Deep approach, partially verifying its convergent validity evidences. These positive and negative associations of the styles with the Deep and Surface approach are likely to be expected since styles describe features related to information processing in learning. Such features include diverse types of interests and motivations involved in the notion of learning approaches (Biggs & Tang, 2011). It is important to note that these results are in line with a previous study which reported how, on the one hand, the styles' dimensions join with the Deep approach whilst on the other hand, they are negatively associated with the Surface approach (Cano-García & Justicia-Justicia, 1994). With respect to the low associations found, these could be explained by the differences between the concepts under analysis. Even though styles and approaches are theoretically related, they imply two rather different perspectives on students dealing with learning situations. On the one hand, learning styles examine the students' self-perceptions about their cognitive, emotional and physiological preferences when they manage learning activities. On the other hand, learning approaches are related to motivation and strategies employed as a result of how students perceive the learning context. Additionally, it is worth mentioning that low associations are likely to be found in larger and heterogeneous samples (Ranganathan & Aggarwal, 2016).

Seventh, the study has some weaknesses which deserve special attention. One of them relates to the sample used,

which does not include all the faculties composing the higher education system in Buenos Aires. Another limitation lies in the lack of analysis of predictive validity evidences taking academic achievement or learning quality as criteria. Such issues, therefore, should be addressed in new studies gathering data in more heterogeneous samples, and including indicators of academic achievement -e.g, grade point average or learning quality indices-.

Eighth and last, this study reported similar findings to the ones concerning the internal structure of CHAEA, obtained in its first local adaptation. This is, therefore, new evidence which strengthens the hypothesis stating the generalization of this model in college students from Buenos Aires. Thus, not only previous evidences on the local version of CHAEA were confirmed, but also new evidences were introduced here. As for practitioners in Educational Psychology, these results could be useful to offer more certainty about assessments conducted with CHAEA. In consequence, decisions aimed at improving learning quality would become easier as far as they are based on CHAEA's results. For instance, such results could be useful to plan tailored workshops, specific training programs for teachers, syllabi changes, and major study programs reviews.

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