Pyschometric Properties and the Factor Structure of the Spanish Version of the Cognitive Adaptability Scale (MAC)*

Propiedades psicométricas y estructura factorial de la versión española de la Escala de Adaptabilidad Cognitiva (MAC)

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ABSTRACT

In the context of entrepreneurship, cognitive adaptability is a key competence. Thus, researchers in this field are making an effort to find instruments to measure this ability in a way that allows us to predict success in the context of enterprise creation or intention. We conducted a series of exploratory and confirmatory analyses of the cognitive adaptability scale (MAC), using a sample of Spanish ($N = 494$), in addition to the reliability and validity analyses. We found that a three-factor solution of the MAC best fit the data. The reliability coefficients of consistency were acceptable. The validity of the MAC was confirmed by its correlation with Need for Cognition (NFC). The NFC measures the degree to which individuals enjoy cognitive activity. The present study suggests that more studies are needed in different contexts that would allow the structure of cognitive adaptability to be validated, improved or modified.

Key words authors
Entrepreneurship, cognitive adaptability, metacognition, factorial validity.
Key words plus
Psycholgical tests, validation, psychometry, quantitative research.

RESUMEN

En el contexto del emprendimiento, la adaptabilidad cognitiva es una competencia clave. Por lo tanto, los investigadores en este campo están haciendo esfuerzos para encontrar instrumentos que midan la capacidad de emprendimiento y que permitan predecir el éxito en el contexto de la intención o creación de empresas. Utilizando una muestra española ($N = 494$), Se llevaron a cabo una serie de análisis exploratorios y confirmatorios de la Escala de la Capacidad de Adaptación Cognitiva (MAC), utilizando una muestra española ($N = 494$), además de la confiabilidad y validez de los análisis. Se encontró una solución de tres factores del MAC que se ajusta mejor a los datos. Los coeficientes de fiabilidad fueron aceptables. La validez de la MAC fue confirmada por su correlación con Necesidad de Cognición (NFC). La NFC mide el grado en que los individuos disfrutan de la actividad cognitiva. El presente estudio sugiere que se necesitan más estudios en diferentes contextos que permitan que la Escala de Capacidad de Adaptación Cognitiva pueda ser validada, mejorada o modificada.

Introduction

Entrepreneurship is a relatively new field of inquiry. The first studies were carried out from the perspective of personality traits, which made important contributions but also had its limitations when attempting to explain entrepreneurial behaviour. Faced with these limitations, certain authors chose to use the cognitive approach as an alternative (e.g., Bouckenooghe, Van den Broeck, Cools, & Vanderheyden, 2005; Sánchez, 2011; Vecchio, 2003). The cognitive approach is characterized by the study of certain types of cognitions that could explain aspects such as how to define and differentiate an entrepreneur, entrepreneurial behaviour and business success, among others. Researchers using this approach believe that cognitive aspects are the elements that differentiate entrepreneurs from non-entrepreneurs. These cognitive aspects can range from beliefs to values, cognitive styles and mental processes.

In the last decade the Cognitive Psychology has made important contributions to the field of Entrepreneurship in areas such as cognitive styles of entrepreneurs (Bridge, O'Neil, & Cromie, 2003), enterprising self-efficacy (Markman, Baron, & Balkin, 2005), decision-making heuristics (Mitchell et al., 2007), knowledge structures of entrepreneurs (Smith, Mitchell, & Mitchell, 2009), etc. Knowing how these cognitive elements function has helped us to understand how entrepreneurs perceive and interpret information and how they use it to make the decision to start a successful business.

One of the most developed and fertile cognitive constructs is metacognition. According to Schraw and Dennison (1994), *metacognition* refers to the skill of understanding, controlling, and reflecting about one's own learning. It is thus a cognitive process of a higher order that allows individuals to organize what they know about themselves, that

is, about their own learning and knowledge, but also about other people (perceptions as to how people think), tasks (the nature of the information acquired by carrying out a task), situations and changing environments (how information is used in different contexts) and strategy (procedures to ensure that this is the right strategy for attaining the desired goal) in a way that facilitates dynamic and effective cognitive functioning.

This ability to comprehend, control and reflect about one's own learning is important in decision-making, since it means that individuals can identify the possible alternatives for carrying out a task or solving a problem, that is, to make a decision in accordance with their own motivations and the context in question (Glasspool & Fox, 2005; Higham & Gerrard, 2005).

Diverse authors point out that metacognitive ability begins to develop very early in life and increases rapidly during childhood and adolescence. Thus, as individuals grow older the accuracy of their metacognitive processes increases, becoming a key element in adult information processing (Koriat & Shitzer-Reichert, 2002; Schneider, Visé, Lockl, & Nelson, 2000). This skill varies from person to person, and there is no empirical evidence that suggests it can be developed through training (Schmidt & Ford, 2003).

One product of metacognition is cognitive adaptation, understood as the ability to evolve or to adapt decisions in a suitable and effective way based on feedback from the context (inputs) in which the cognitive processing is involved (Haynie & Shepherd, 2009). This ability to adapt is made possible through strategies that promote the process of thinking about thinking, that is, metacognition.

In the context of entrepreneurship, cognitive adaptation is a key competency. For this reason researchers in this field are making an effort to find instruments to measure this ability in a way that allows us to predict success in decision-making in new learning situations in the context of enterprise creation (Haynie & Shepherd, 2009; Haynie, Shepherd, & Patzelt, 2010).

Measuring cognitive adaptability in the field of entrepreneurship

Schraw and Dennison (1994) posed the creation of an instrument to measure metacognitive awareness in adults and adolescents that would be easy to apply. Starting from existing conceptualizations, these authors based their questionnaire on the measurement of the two categories comprising metacognition: *knowledge* and *regulation* of cognition. Knowledge of cognition refers to three processes that facilitate the reflective aspect of metacognition. These are: knowledge about ourselves and the strategies we possess (declarative knowledge), knowledge of how to use these strategies (procedural knowledge), and finally, knowledge about when and why we should use these strategies (conditional knowledge). Different processes that facilitate learning measure the regulation of cognition. Different authors (e.g., Arzt & Armour-Thomas, 1992) have pointed out a group of five skills or processes that permit the regulation of cognition: planning, information management strategies, monitoring strategies, comprehensive vigilance and evaluation. All these processes (knowledge and regulation) are included in a questionnaire comprising 52 items that provides an initial reliable measure of metacognitive awareness and is valid for students.

Haynie and Shepherd (2009) conceptualize and measure cognitive adaptability as the aggregate of five metacognitive dimensions: goal-orientation, metacognitive knowledge, metacognitive experience, metacognitive control and metacognitive monitoring. The main assumption is that metacognitive awareness represents a bridge to cognitive adaptability and is based on the following logic: individuals perceive and assign meaning to the characteristics of the environment within the context of their own objectives. Afterwards, they add this information to their metacognitive knowledge and metacognitive experiences, in order to, then, generate multiple decision-making structures centred round interpreting, planning, and implementing objectives in order to manage a changing environment. The individual selects a structure from this set and carries it out (metacognitive control),

eliciting some kind of outcome (cognitive and/or behavioural). These outcomes are related to the objectives or goals of the individual, who will use feedback mechanisms to generate and select new decision-making contexts according to the new circumstances.

These authors uphold that metacognition represents the cognitive foundation of entrepreneurial thinking and that people who make decisions under metacognitive processes are more aware that each specific situation can be analysed from different points of view and as a result, that they should consider the different alternatives and take into account the feedback from this for future decisions. Thus, the more metacognitive awareness a person has, the more adapted that person's response can be in a changing environment.

As Haynie et al. (2010) point out, most studies on business success have focused on understanding its antecedents, especially in regard to the previous knowledge that entrepreneurs have about the business world, even to the point of demonstrating how business failure has to do with a lack of previous knowledge or how individuals with no experience detect fewer business opportunities. Hence, whereas much research has been done regarding the influence of previous knowledge on venture success, very little study has been devoted to the capabilities and skills that could mitigate the negative consequences of a lack of knowledge. Among these competencies, these authors highlight cognitive adaptability.

Starting from the basis that knowing how to detect and adapt to environmental uncertainty by making the most of business knowledge is a key competency, but that many people lack prior business knowledge, Haynie et al. (2010) used the measure cognitive adaptability (MAC) to study the role of metacognitive ability and feedback in the successful realization of an entrepreneurial task by persons who had no previous experience in entrepreneurship. They found that the metacognitive ability of an individual helps to explain why certain persons with no experience in the enterprising process are better able than others to make use of feedback to suitably and consistently

adapt their decision policies to those of a sample of expert entrepreneurs.

In Spain there is currently no validated instrument for measuring cognitive adaptability, and therefore a questionnaire adapted to Spain could be a useful instrument for advancing in the study of the psychological variables affecting the entrepreneurship process in university students. The aim of the present study is to further the development of the applicability of the instrument for measuring cognitive adaptability (MAC) by studying its reliability as a measurement instrument and its predictive value.

Method

Participants

The total study sample comprised 494 university students with a mean age of 20.9 (*SD* 4.7). Of these, 23.6% were men and 76.4% were women. Regarding their studies, 67.2% were full degree course students (Psychology, Pedagogy, Economics); 25.8% were enrolled in a three-year diploma course, and 7% were post-graduate students.

Selection of the sample was determined by the nature of the constructs to be studied. The use of samples comprising students has its detractors and defenders. For instance, Audia, Locke, and Smith (2000) uphold that student samples are an important first step in exploring the psychological bases of managerial behaviour. Moreover, we must not forget that metacognition develops throughout childhood and reaches maturity in the first stage of adulthood (Schraw, 1998), and therefore university students show stable and defined dimensions of metacognitive processing. A further reason why a student sample is appropriate for studying metacognitive processing is that they have not yet had enough experience to develop other automatic and heuristic processing mechanisms.

Another reason for using a sample of university students is that they may be more heterogeneous than entrepreneurs as regards metacognition (Dipboye & Flanagan, 1979; Glenberg & Epstein, 1987). Like Haynie and Shepherd (2009), we argue that

owing to their own experience in the field, a sample comprising entrepreneurs could limit the empirical study of metacognition and this limitation could in turn have an impact on the usefulness of a metacognition measure when differences in cognitive adaptability among different levels of entrepreneurship are examined, including those that have not yet taken a single step towards an enterprising action.

Instrument

The instrument studied is the Measure of Adaptive Cognition (MAC) by Haynie and Shepherd (2009), comprising 36 items to be answered on a Likert-type scale ranging from 0 (*I never do that*) to 5 (*I always or almost always do that*) points.

The MAC is an adaptation to the entrepreneurship context of an instrument developed by Schraw and Dennison (1994) to assess metacognitive awareness in an educational framework. Haynie and Shepherd (2009) rewrote the items to eliminate the influence of the educational context and focused the questions on generic tasks or situations. Nine of the original items were eliminated because their educational bias could not be removed. Eleven additional items were added to the adapted questionnaire that reflect the theoretical dimensions forming the basis of the Metacognitive Awareness model for an initial instrument of 54 items. Following the pre-test, Haynie and Shepherd eliminated 12 items owing to their low correlation with the dimensions proposed, leaving a questionnaire with 42 items that describe each of the dimensions of metacognitive awareness. A further six items were removed since they did not have a significant loading on any factor, for a definitive questionnaire comprising 36 items. These authors responded to our proposal to validate the MAC instrument and they provided us not only with the instrument, but also with the instructions for completing and correcting it.

Since the sample collected for the validation is Spanish, the questionnaire was translated into Spanish using the translation/back-translation technique (Behling & Law, 2000). Some authors have argued that this methodology for language adaptation is

good practice in the design of questionnaires (Hilton & Skrutkowski, 2002) and can help to reduce the differences between the different versions.

Analyses

Although we started with a prior factor structure we decided to first run Exploratory Factor Analysis (EFA) and then Confirmatory Factor Analysis (CFA). The parameters in a Factor Analysis are normally estimated through Maximum Likelihood (ML). This index is the most reliable one, although it requires an assumption of multivariate normality (Wegener & Fabrigar, 2000). Bernstein (1988) suggests that to find out whether multivariate normality has been violated, we should consider the means and standard deviations in each factor. If large differences are found in the means and standard deviations, we can assume that multivariate normality has been violated.

To determine whether the data were suitable for ML analysis, we considered an anti-imaging correlation, which quantifies the correlation between the items on the questionnaire, and Bartlett's Test of Sphericity, which examines whether the items on the correlation matrix are not correlated (Nunnally & Bernstein, 1994). A significance level below $p < 0.05$ indicates that the data are suitable for factor analysis.

Once the correlations were analysed we used oblique rotation, specifically promax rotation, since it provides the best description of the patterns of the correlated factors, identifying the degree to which each of the factors is correlated. Moreover, oblique rotation is the most flexible in searching for patterns regardless of their relation (Reis & Judd, 2000).

Since the weights of the factors show errors, they will be interpreted and differentiated strictly according to statistics and for their practical importance. Only the "sufficiently strong" loadings will be true factors and should be interpreted significantly in practice. Thus, we take into account the inflation in the standard errors of the factor loadings in order to determine their appropriate level of importance.

Confirmatory factor analysis

To determine the set of resulting factors we used a structural equation model to investigate the level of significance and the direction of the correlations between factors. This analysis also allows us to compare the 5 factor model by Haynie and Shepherd with possible alternative interpretations of the correlations within the data matrix. We consider several recommended goodness-of-fit measures, such as the Normalised Fit Index (NFI), Root Mean Square Error of Approximation (RMSEA), the Chi-Squared with degrees of freedom (χ^2/df), and the Goodness of Fit Index (GFI). Generally, values above 0.9 indicate a good fit of the model for the NFI and GFI (Hatcher, 1994). Hu and Bentler (1999) suggested that a "limit" value for the RMSEA is approximately 0.06. Finally, values below 5 indicate a good fit of the model in the chi-squared/degrees of freedom ratio (Wheaton, Muthen, Alwin, & Summers, 1977).

Reliability

Reliability describes a condition in which the measurement scale is consistent over time. Several types of statistical reliability have been described. In the Social Sciences, internal consistency is the one most employed. In this study internal consistency is tested with Cronbach's alpha. Although there is no standard cut-off point for the alpha coefficient, it is generally agreed that the lowest acceptable value is 0.7, which indicates a moderate internal consistency (Nunally, 1978).

Validity

Validity tests focus on examining both internal (within the measure, between factors) and external (between measures, through comparison with other measures) validity. A measurement instrument has internal validity when it is demonstrated that the measures that should not be related to each other are in fact not related, and it is assessed by comparing the mean values of extracted variance associated with each construct with the correla-

tions between constructs (Staples, Hulland, & Higgins, 1999).

External validity was established by comparing the correlations between the MAC and an additional scale included for this purpose, the "Need for Cognition" (NFC) scale (Cacioppo, Petty, & Kao, 1984). In this sense, MAC scores are expected to correlate with the scores on the NFC scale. The NFC scale measures the degree to which individuals enjoy cognitive activity, such high scores on the NFC are indicative of commitment to and satisfaction with challenging cognitive tasks, and therefore we expected the NFC to correlate strongly and positively with the MAC.

Results

Bartlett's Sphericity test yielded a value of $p < 0$, and the Measure of Sampling Adequacy by Kaiser-Meyer-Olkin gave 0.88. As a result of these pre-tests, 5 of the 36 original items were eliminated from the item pool and from subsequent analyses, because the measure of sampling adequacy for each of these items

was below 0.8. The MSA statistic for the group of remaining items was 0.9, indicating that the data are more than fit for application of factor analysis (Hair, Anderson, Tatham, & Black, 1998). Furthermore, the level of significance of Bartlett's Sphericity test was broad enough to allow us to reject the hypothesis that the variables were unrelated.

Factor analysis using ML with PROMAX rotation and forcing the solution to five factors explained 47.18% of the variance. Examination of the resulting scree plot confirmed the five factor solution. The goodness of fit test was significant ($p < 0$ 0) and therefore we did not reject the null hypothesis that the discrepancy between the observed variance and the predicted variance equals 0. Six items did not load significantly on any factor and were eliminated from subsequent analyses. We also decided to eliminate two of the resulting factors since the reliability of the items in these factors was below 0.7. Table 1 shows the factor loadings, eigenvalues, statistics of explained variance and all the loadings above 0.4, as well as the reliability of each factor.

TABLE 1
Maximum Likelihood Loading

Inventory item	Factor 1 (metacognitive knowledge)	Factor 2 (metacognitive monitoring)	Factor 3 (metacognitive control)
Item 2	0.552		
Item 5	0.619		
Item 6	0.568		
Item 7	0.449		
Item 16	0.585		
Item 19	0.443		
Item 17		0.479	
Item 23		0.846	
Item 31		0.441	
Item 35		0.41	
Item 26			0.447
Item 30			0.546
Item 33			0.465
Item 36			0.823
Eigenvalue variance	8.62	1.6	1.54
Percentage (cumulative)	27.8	5.18 (32.99)	4.97 (37.96)
Crombach's a	0.73	0.73	0.7

Source: Own work.

To confirm this factor structure we used the structural equation modelling. The results indicate that the three dimensions are significantly correlated ($p < 0.05$) and that the correlations are positive, meaning that together these dimensions capture general cognitive adaptability. CFA showed a good fit of the three factors to the model that was the result of EFA. Despite the lack of unanimity as to the optimum cut-off values in the fit indices of structural models, most experts agree that values equal to or above 0.9 in the Comparative Fit Index (CFI) and the Normed-Fit Index (NFI) are acceptable, and are considered excellent when above 0.95. For its part the Root Mean Square Error of Approximation (RMSEA) is considered acceptable when lower than 0.08, and excellent when equal to or lower than 0.05 (Fan & Sivo, 2005). In our case, the indicators obtained (Table 2) point to an acceptable fit of the model, with all the indices close to values considered excellent.

Internal consistency was examined using Cronbach's alpha. The reliability obtained for each of the three dimensions of cognitive adaptability can be considered acceptable (Table 1). Nunnally and Bernstein (1994) suggest that in the first stages of research, instruments that have a moderate level of reliability can be used (e.g., 0.7) and that to try to increase reliability to values above 0.8 in basic research is often a waste of time and money (p. 265). Our results indicate that the reliability obtained can be considered valid for the objectives of our study. Moreover, Cronbach's alpha for the MAC (all items) was 0.84, indicating a high degree of internal consistency for this measure.

The validity tests run focused both on validity among the MAC factors (internal validity) and comparisons between the MAC and other instruments (external validity). In regard to internal validity, we observed that the measures that should not be related to one another are indeed unrelated, as was also observed when we compared the average variance extracted (AVE) values associated with each construct to the correlations among constructs. In Table 3, the elements on the diagonal show the square root of AVE, whereas the elements outside the diagonal show the correlations between the dimensions. The elements on the diagonal should be greater than any others corresponding to the rows or columns (Staples et al., 1999), as is the case here. Finally, external validity, as mentioned earlier, was established by comparing the correlations between the MAC and the NFC. With a correlation of 0.27 ($p < 0.01$), our results endorse this relation.

TABLE 2
Goodness of Fit Statistics

Model	N	χ^2/df	CFI	NFI	GFI	RMSEA
		Measure of adaptive cognition/Goodness of fit indices				
3-Factor model	294	2.3	0.904	0.897	0.907	0.067

CFI: comparative fit index; NFI: normed-fit index; GFI: goodness-of-fit index; RMSEA: root mean squared error of approximation.
Source: Own work.

TABLE 3
Statistical Structure Analysis

Constructs	Factor 1 (metacognitive knowledge)	Factor 2 (metacognitive monitoring)	Factor 3 (metacognitive control)
Factor 1	0.688		
Factor 2	0.55	0.668	
Factor 3	0.475	0.508	0.721

Note. The bold diagonal elements are the square root of the variance shared between the constructs and their measures (i.e., the average variance extracted). Off-diagonal elements are the correlations between the constructs. Validity is demonstrated if the off-diagonal elements are larger than any corresponding row or column entry.
Source: Own work.

Discussion

Early research into entrepreneurship focused on analysing which traits could differentiate entrepreneurs from non-entrepreneurs. When this failed, researchers became somewhat discouraged and soon this approach was abandoned. Nonetheless, in recent years scholars have returned to these psychological roots, this time focusing on the cognitive process of entrepreneurs. Thus, the study of decision-making processes has been defended from the conceptualization of the entrepreneurial mind-set as basic to the analysis of entrepreneurial success. However, the literature in this field is still scant, especially if we consider the cognitive anchoring of the entrepreneurial mind-set and other similar concepts of entrepreneurial cognition.

Researchers interested in entrepreneurial cognition have focused mainly on the processes that inhibit cognitions in order to adapt successfully to the environment, but few studies have addressed an analysis of the cognitive processes that may allow entrepreneurs to foster cognitions adaptive to the entrepreneurial context. Cognitive adaptability is important in entrepreneurial contexts because the latter are characterised by rapid, discontinuous change (Hitt, 2000), and thus represents a differential variable that may help to increase our knowledge of the cognitive factors that influence key aspects of the entrepreneurial process (Baron & Ward, 2004).

To measure cognitive adaptability in the field of entrepreneurship, Haynie and Shepherd (2009) developed an instrument based on previous research. The objective of the present study was thus to adapt this instrument to the context of Spain, given the current scarcity of measuring instruments for assessing entrepreneurs or potential entrepreneurs in this country. The results of our study show the tri-dimensionality of cognitive adaptability as opposed to the five dimensions proposed by Haynie and Shepherd (2009), and the resulting instrument has been shown to have good psychometric properties, as seen in its factor structure and its validity. This factor structure is partly consistent with the theoretical dimensions found in other studies.

We consider that this instrument opens new opportunities for assessing cognitive adaptability in different entrepreneurial contexts and can help to improve the competencies needed for successful enterprising.

Nonetheless, we also believe that since the factor structure proposed by Hayne and Shepherd could not be confirmed, more studies are needed in this respect and in different contexts that would allow the structure of cognitive adaptability to be validated, improved or modified.

The analysis of metacognition has implications for the teaching of entrepreneurship and for education in general, since research has demonstrated that metacognition can be taught and thus individuals' cognitive adaptability can be improved (Schmidt & Ford, 2003). Accordingly, the consideration of cognitive adaptability in the designing of curricula could improve the education of future entrepreneurs and managers. Also, future research should pose what types of emotions students undergo during an entrepreneurial training programme? How these emotions relate to the 'enterprising passion' construct? How emotional style affects cognitive rationality? (Guarino, 2011).

Cardon, Vincent, Singh, and Drnovsek (2005) suggested that intense emotions may impede cognitive reality. That is, it is not enough to just teach metacognition, but rather to develop and foster the "entrepreneurial drive" in students (Florin, Karri, & Rossiter, 2007). These authors define "entrepreneurial drive" as an individual's perception of the desirability and feasibility to proactively pursue opportunities and creatively respond to challenges, tasks, needs, and obstacles in an innovative way. In this sense, this aspect should be further developed and researched in the context of entrepreneurship education, in order to understand new antecedents of entrepreneurial intentions to create new businesses and to provide a favourable climate in which entrepreneurship can flourish

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