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Relation between Personality and Metacognitive Regulation in a Sample of University Students from Different Countries in Latin America

Relación entre factores de personalidad y el conocimiento y la regulación metacognitiva en una muestra de estudiantes universitarios de diferentes países de habla hispana

Relação entre fatores de personalidade e o conhecimento e a regulação metacognitiva em uma amostra de estudantes universitários de diferentes países de língua espanhola

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Abstract: This research investigates the relationship between personality factors and metacognition in a sample of undergraduate students from Argentina, Colombia, Costa Rica, Panama, and Uruguay. Recognizing the interdisciplinary nature of cognitive science, the study emphasizes the importance of metacognitive abilities—considered executive functions—on academic performance. The sample consisted of 692 students, aged 20 to 30, from various undergraduate programs. Participants completed the Metacognitive Awareness Inventory (MAI) and the Adjective Checklist for Evaluating Personality (AEP). The analysis used multiple regression to examine the relationship between the five major personality factors and eight metacognitive variables across the five countries. Results indicated significant associations between personality traits and metacognitive components, with conscientiousness and openness to new experiences consistently predicting metacognitive regulation and knowledge. These findings align with previous studies suggesting that personality traits influence metacognitive abilities. The study contributes to the understanding of how individual differences in personality can affect learning processes, highlighting the potential for targeted interventions to enhance metacognitive skills.

Keywords: learning; metacognition; personality; university students; cross cultural studies

Resumen: Esta investigación examina la relación entre los factores de personalidad y la metacognición en una muestra de estudiantes de pregrado de Argentina, Colombia, Costa Rica, Panamá y Uruguay. A partir de la naturaleza interdisciplinaria de la ciencia cognitiva, el estudio enfatiza la importancia de las habilidades metacognitivas, consideradas como funciones ejecutivas fundamentales en el desempeño académico. La muestra se conformó por 692 estudiantes, de 20 a 30 años, de diversos programas de pregrado. Los participantes completaron el Inventario de conciencia metacognitiva (MAI) y el Listado de adjetivos para evaluar la personalidad (AEP). En el análisis se utilizó regresión múltiple para examinar la relación entre los cinco grandes factores de personalidad y ocho variables metacognitivas en los cinco países. Los resultados indicaron asociaciones significativas entre los factores de personalidad y los componentes metacognitivos, con la escrupulosidad y la apertura prediciendo consistentemente la regulación y el conocimiento metacognitivo. Estos hallazgos se alinean con estudios previos que sugieren que los factores de personalidad influyen en las habilidades metacognitivas.

El estudio contribuye a la comprensión de cómo las diferencias individuales en la personalidad pueden afectar los procesos de aprendizaje, destacando el potencial de intervenciones dirigidas para mejorar las habilidades metacognitivas.
Palabras clave: aprendizaje; metacognición; personalidad; estudiantes universitarios; estudios transculturales

Resumo: Esta pesquisa examina a relação entre os fatores de personalidade e a metacognição em uma amostra de estudantes de graduação da Argentina, Colômbia, Costa Rica, Panamá e Uruguai. Com base na natureza interdisciplinar da ciência cognitiva, o estudo enfatiza a importância das habilidades metacognitivas, consideradas como funções executivas fundamentais no desempenho acadêmico. A amostra foi composta por 692 estudantes, com idades entre 20 e 30 anos, de diversos programas de graduação. Os participantes completaram o Inventário de Consciência Metacognitiva (MAI) e a Lista de Adjetivos para avaliar a Personalidade (AEP). Na análise, utilizou-se regressão múltipla para examinar a relação entre os cinco grandes fatores de personalidade e oito variáveis metacognitivas nos cinco países. Os resultados indicaram associações significativas entre fatores de personalidade e componentes metacognitivos, com a conscienciosidade e a abertura prevendo consistentemente a regulação e o conhecimento metacognitivo. Esses achados se alinham com estudos anteriores que sugerem que os fatores de personalidade influenciam as habilidades metacognitivas. O estudo contribui para a compreensão de como as diferenças individuais de personalidade podem afetar os processos de aprendizagem, destacando o potencial de intervenções direcionadas para melhorar as habilidades metacognitivas.
Palavras-chave: aprendizagem; metacognição; personalidade; estudantes universitários; estudos transculturais

Introduction

Cognitive sciences, which include fields as diverse as psychology, linguistics, neuroscience, artificial intelligence, among others, contribute to positioning the idea of an active student who, in addition to having proficient cognitive and academic performance, is capable of learning autonomously and who is self-regulated, based on their own agency. Some authors consider metacognition itself to be an executive function (Ardila & Ostrosky-Solís, 2008; Flores-Lázaro et al., 2014; Follmer & Sperling, 2016) that allows a person to think about their own cognitive processes and products (Flavell, 1979; 1987) or, in other words, to think about thinking (Ozturk, 2020; Topping, 2024; Veenman et al., 2006). This monitoring capacity is considered a skill that can be developed and taught through strategy instruction (Gutierrez de Blume, 2022; Nobutoshi, 2023; Silver et al., 2023; Zsigmond et al., 2025). Metacognitive monitoring is understood as individuals' ability to successfully understand what they are learning and generally involves a series of metacognitive activities such as questioning, reflection, inference-making, and self-generated feedback. These skills allow individuals to recognize their mastery or understanding of a topic, or when they need to modify their learning strategies to improve their performance (Gutierrez de Blume, 2022; Zsigmond et al., 2025).

Studies conducted with very different interventions and research designs indicate that metacognition can be developed and practiced through appropriate instruction. However, some of the research referring to the effects of interventions on metacognitive monitoring remains inconclusive regarding differences in the effect sizes of monitoring accuracy, with contradictory, inconsistent results (Bol et al., 2005; Bol & Hacker, 2001; Gutierrez & Schraw, 2015; Nietfeld et al., 2005; Pesout & Nietfeld, 2020; Schraw et al., 2014; Wongdaeng, 2022; Yang et al., 2023).

The high variability in the results of interventions and in the reported effect sizes can be explained by the diversity of contextual and sociodemographic variables inherent in these intervention studies on metacognitive monitoring. Contextual variables include classroom climate, teaching style, type of strategies used, and characteristics of the study (Abello et al., 2022; Alonso-Tapia & Ruiz-Díaz, 2022; Bryce et al., 2015; Chiarino et al., 2024; Farrington et al., 2012; Forsberg et al., 2021; Gutierrez de Blume, 2022; Morosanova et al., 2022). Likewise, this diversity is evident in relation to person-centered variables such as learning goals, the cognitive profile of the learner, affect/emotions, academic persistence, growth mindset, and personality factors (Abello et al., 2022; Alonso-Tapia & Ruiz-Díaz, 2022; Bryce et al., 2015; Chiarino et al., 2024; Farrington et al., 2012; Forsberg et al., 2021; Gutierrez de Blume, 2022; Morosanova et al., 2022). Overall, however, there is consensus that general metacognition, including its different subcomponents, can be taught in different learning situations. By the same token, this macro-skill is expected to transfer to new learning experiences according to different environmental demands (Azevedo, 2020; Chew et al., 2018; Chew & Cerbin, 2020; Veenman et al., 2006). In this sense, teaching metacognitive skills fosters the development of students for whom deep learning is possible, a learning objective that requires students to reflect on their own understanding and their

own learning process (Sawyer, 2019; 2022). However, the fact that it can be taught as a skill does not necessarily mean that the student will learn it, or that, even if they do learn it, they will be truly aware of how they are learning and willing to use metacognitive skills to achieve more effective performance. In fact, different studies argues that the presence of underconfidence and overconfidence biases inherent to metacognitive judgments and reports of difficulties in discriminating the feeling of knowing and not knowing in students who have difficulties with their metacognitive monitoring process, especially for students with low academic performance (Bol et al., 2005; Chang & Brainerd, 2023; De Bruin et al., 2017; Geraci et al., 2023; Hacker et al., 2000; Kelemen et al. 2007; Kruger & Dunning 1999; Miller & Geraci, 2011; Nietfeld et al., 2006; Zapata-Zapata et al., 2024).

Some studies show overconfidence in predictive judgments on achievement tests, especially among low-achieving students, a phenomenon known as the Dunning-Kruger effect. In contrast, high-achieving students demonstrate more accurate predictions in their performance and moderate their confidence levels relative to their actual performance (Bol et al., 2005; Chang & Brainerd, 2023; De Bruin et al., 2017; Geraci et al., 2023; Hacker et al., 2000; Kelemen et al. 2007; Kruger & Dunning, 1999; Miller & Geraci, 2011; Nietfeld et al., 2006; Zapata-Zapata et al., 2024).

The association between personality factors and metacognitive performance has been relatively understudied. Seminal studies addressing this relationship can be traced back to research led by Wolfe and Grosch (1990), a study that has grown in popularity since the work of researchers such as Kleitman (2008) and Buratti (2013).

Previous studies have indicated a positive relationship between personality traits such as extroversion and overconfidence (Dahl et al., 2010; Pallier et al., 2002; Schaefer et al., 2004). Similarly, there is evidence of an association between the trait of narcissism and overconfidence, possibly because these types of personalities often consider themselves more intelligent than objective performance measures suggest (Buratti et al., 2013; Campbell et al., 2004). On the contrary, in some studies on the association between the components of self-regulated learning and personality, high correlations have been reported between metacognitive measures and personality factors such as conscientiousness and openness to new experiences, and in turn, high correlations between academic performance and these same personality factors (Dumfart & Neubauer, 2016; Kelly & Donaldson, 2016; Morosanova et al., 2022; O'Connor & Paunonen, 2007). Presumably, this can partially be explained by the abstract nature of the construct, given its many theoretical models and the lack of agreement among researchers in the field regarding the components of metacognition and self-regulated learning (Dinsmore et al., 2008; Lyons & Zelazo, 2011; Tobias & Everson, 2009; Zohar & Dori, 2012). In addition, researchers have begun to acknowledge the influence of sociodemographic factors like personality differences and their possible association with the metacognitive performance of the learner (Bibi et al., 2022; De Bruin et al., 2017; Gutierrez de Blume & Montoya Londoño, 2023; Kleitman & Stankov, 2001; 2007; Pallier et al., 2002; Stankov et al., 2014).

Most studies linking the importance of personality factors in the formulation of metacognitive judgments have described associations between metacognitive performance and the personality traits of extraversion, narcissism, need for cognition, and overconfidence (Campbell et al., 2004; Dahl et al., 2010; Pallier et al., 2002; Ronningstam, 2005; Schaefer et al., 2004; Wolfe & Grosch, 1990). Similarly, traits such as openness and level of trust have been associated with the proportion of correct responses (Dahl et al., 2010; Kleitman, 2008) whereas neuroticism/emotional stability shows a negative correlation with feelings of insecurity and trust for different judgment tasks (Mirels et al., 2002; Want & Kleitman, 2006). Yet other studies have described the association between factors such as openness and extraversion with overconfidence in the formulation of first and second order metacognitive judgments (Buratti, 2013; Buratti et al., 2013).

More recently, a study conducted with 244 undergraduate foreign language students in Turkey aimed to establish the relationship between metacognition and personality traits and their interaction with foreign language performance. The results confirmed that factors such as conscientiousness, openness to experience, and agreeableness accounted for 20% of the variability in metacognitive knowledge, and that factors such as conscientiousness and openness to experience accounted for 16% of the variability in metacognitive regulation. Further, factors such as conscientiousness and extroversion predicted reading performance while conscientiousness and openness to experience were significant predictors of language performance (Ozturk, 2021). Another study conducted with 102

college students taking several psychology courses at a university in the southeastern United States examined the association between personality factors, reading comprehension, and metacomprehension accuracy before and after taking a test. Results revealed that openness to experience correlated positively with all confidence assessment measures applied in the reading comprehension task, but did not correlate with actual reading performance or with actual grades, indicating that participants exhibited overconfidence regarding their performance. Likewise, factors such as extroversion correlated negatively with self-reported reading performance and did not predict actual reading performance (Agler et al., 2021). Given the inconsistent findings regarding personality, the present study sought to explore the relationship between personality factors and metacognition in a sample of university students from different Latin American countries.

Research Question

What is the predictive effect of personality factors on metacognitive knowledge and regulation in a sample of undergraduate students from Argentina, Colombia, Costa Rica, Panama, and Uruguay?

Hypothesis

Given that studies demonstrating an association between these variables have yielded diverse and inconclusive results (Bidjerano & YunDai, 2007; Blair et al., 2010; De Bruin et al., 2017; Dörrenbächer & Perels, 2016), the present study posited a general, non-directional rather than a specific, directional hypothesis, expecting some factors such as conscientiousness to correlate positively with metacognition while others such as neuroticism would correlate negatively.

Method

Participants, Sampling, and Research Design

This study employed a non-experimental, cross-sectional quantitative research design with a non-random convenience sampling approach (Tabachnick & Fidell, 2019). The participants were 692 students from different undergraduate programs (mostly psychology and education) from Argentina, Colombia, Costa Rica, Panama, and Uruguay, who were pursuing their educational careers during the year 2023 (post-pandemic). The sample consisted of 305 men and 387 women.

This project received ethical approval from the University of Manizales, Colombia, under the title: "Metacognitive Functioning in the Performance of Teachers and Students from Different Countries. Intercultural Analysis," with bioethical approval in Colombia through internal code FCSH-202006.

The sample was selected intentionally via convenience sampling. Because the participants were pursuing their educational careers at the universities where the authors work, they were first informed of the study's objectives. Those interested in voluntarily participation read and signed an informed consent form.

All students who participated in the study met the following inclusion criteria: age between 20 and 30 years; absence of psychological and/or psychiatric disorders or history of academic failure (this question was asked directly to the students individually as part of the sociodemographic data collection process during a meeting to sign the informed consent form).

Materials and Instruments

Metacognitive Awareness Inventory (MAI; Schraw & Dennison, 1994). In its original format, this test is a 52-item inventory, grouped into eight subcomponents to measure adults' metacognitive knowledge and regulation. Scores for each item are marked by a 10-cm vertical bar on a continuous bipolar scale ranging from 0 to 100, where 0 represents "not true for me" and "very true for me" is represented by a score of 100. This rating scheme is superior to an ordinal Likert scale because it increases the instrument's reliability by increasing the variability of responses (Gutierrez, 2012; Schraw & Dennison, 1994; Weaver, 1990). Participants' scores on individual scales were obtained by summing all items on that scale and taking the average. Therefore, each participant had eight composite outcomes, one for each of the components of metacognitive knowledge and regulation. Studies using this tool have reported Cronbach's alpha reliability coefficients ranging from .74 to .91 (Gutierrez de Blume & Montoya Londoño, 2021; Gutierrez de Blume et al., 2023; Gutierrez de Blume et al., 2024; Schraw & Dennison, 1994).

Adjective Checklist for Assessing Personality (AEP; Ledesma et al., 2011; Sánchez & Ledesma, 2007; 2013). This instrument is structured based on the Big Five model of personality (Goldberg, 1992,

1993; Goldberg et al., 2006) through a list of 67 adjectives that describe personality traits. Cronbach's alpha for the test ranges from .75 for the openness factor to .85 for the neuroticism factor (Ledesma et al., 2011; Sánchez & Ledesma, 2013). The same rating scheme for the MAI was used for the AEP as well (i.e., a continuous 0-100 scale with two qualitative anchors at either end).

Table 1 reports the reliability indices for this study's sample. McDonald's omega was used instead of Cronbach's alpha for all self-report measures because it is a more conservative reliability coefficient (Tabachnick & Fidell, 2019).

Table 1

*Reliability Coefficients, McDonald's omega, for the Eight Subscales of the MAI and the Five Personality Factors of the AEP (*N *= 692)*

Subscale	ω
AEP	
Extraversion	.81
Agreeableness	.78
Neuroticism	.75
Conscientiousness	.86
Openness to Experience	.80
MAI: Knowledge of Cognition	
Declarative	.74
Procedural	.74
Conditional	.77
MAI: Regulation of Cognition	
Planning	.79
Information Management	.80
Debugging	.78
Comprehension Monitoring	.74
Evaluation of Learning	.81

Procedure

For data collection, students from the participating countries were convened at two different times by the lead researchers in each country. First, students were presented with the objectives and rationale of the research. Subsequently, students interested in participating read and signed the informed consent form. During this time, the lead researcher in each country was available to answer any questions. Next, students completed the protocol in a single session, consisting of the MAI (Schraw & Dennison, 1994; Gutierrez de Blume et al., 2023; Gutierrez de Blume et al., 2024) and the AEP (Ledesma et al., 2011; Sánchez & Ledesma, 2013).

The protocol was implemented in groups by each of the lead researchers in the respective country, all of whom had experience in implementing this type of task and had doctoral training. Likewise, the ethical standards of each country and respect for participant anonymity were considered during data collection. More specifically, the rules and guidelines of the Declaration of Helsinki were followed, and informed consent was obtained from each participant before completing the survey.

Data Analysis

The data were examined for outliers using the regression subcommand (any case with three or more standard deviations from the group means) and tested with the required statistical assumptions prior to analysis. No outliers that would otherwise bias the parameter estimates were detected, and the data met the assumptions of linearity, homoscedasticity, normality, and lack of collinearity between predictors. Therefore, data analysis was performed without making any statistical adjustments to the data. To answer the research questions, the data were subjected to a series of standard ordinary least squares (multiple) regressions in which the five personality factors served as predictors and the eight metacognitive awareness variables served as criteria for each analysis, respectively. This process was repeated for each of the five participating countries. As each country's data were independent of all other countries, the Bonferroni adjustment for statistical significance to avoid inflation of the familywise Type I error rate was only controlled for the eight analyses conducted for each country (the actual *p*-value used for all analyses was $p \leq .01$). The squared multiple correlation coefficient, R^2, was employed

as the effect size for all analyses. Cohen (1988) provided the following interpretive guidelines for R^2: .010–.499 as small; .500–.799 as moderate; and ≥ .800 as large.

Results

In the case of the Argentine sample, the omnibus regression model was statistically significant, $F(5,54) = 6.53$, $p = .012$, $R^2 = .315$. The regression results revealed that the personality factor of openness to new experiences predicts only conditional knowledge, and that both openness and conscientiousness predict only planning within the regulation scales. As individuals' perceptions of their openness increase, so does their perception of their conditional knowledge (i.e., when, where, and why strategies are applied given task demands). Furthermore, the more participants' openness and conscientiousness increase, the more their planning skills improve (Table 2).

Table 2

Ordinary Least Squares Regression Results for Personality and Metacognitive Variables from Argentina

Predictor	B^+ ($CI_{95\%}$)	β^-	*t*	*p*
Conditional Knowledge				
Openness	0.30 (0.06; 0.55)	0.26	2.85	.001**
Planning				
Conscientiousness	0.35 (0.15; 0.74)	0.31	3.08	.001**
Openness	0.42 (0.18; 0.67)	0.39	4.96	.001**

Note. Only statistically significant results are shown for parsimony. $N = 60$. B^+ = Unstandardized regression coefficients and their 95% confidence intervals ($CI_{95\%}$). β^- = Standardized regression coefficients. $^{**}p < .01$.

Similarly, in the Colombian sample, the omnibus regression model was statistically significant, $F(5,346) = 21.93$, $p < .001$, $R^2 = .516$. The regression results revealed that openness to new experiences was the only significant positive predictor of conditional knowledge, and that openness and conscientiousness significantly positively predicted planning and comprehension monitoring. Interestingly, the standardized regression coefficients were higher than in the Argentine sample for all aspects except monitoring (Table 3).

Table 3

Ordinary Least Squares Regression Results for Personality and Metacognitive Variables from the Colombian Sample

Predictor	B^+ ($CI_{95\%}$)	β^-	*t*	*p*
Conditional Knowledge				
Openness	0.61 (0.34; 0.88)	0.51	7.54	< .001**
Planning				
Conscientiousness	0.41 (0.28; 0.64)	0.40	4.33	.001**
Openness	0.53 (0.29; 0.71)	0.45	5.01	.001**
Comprehension Monitoring				
Conscientiousness	0.32 (0.11; 0.42)	0.25	2.86	.01**
Openness	0.44 (0.27; 0.59)	0.41	6.01	.001**

Note. Only statistically significant results are shown for parsimony. $N = 352$. B^+ = Unstandardized regression coefficients and their 95 % confidence intervals ($CI_{95\%}$). β^- = Standardized regression coefficients. $^{**}p \leq .01$.

The omnibus regression model was statistically significant for the Costa Rican sample, $F(5,95) = 8.35$, $p < .011$, $R^2 = .448$, where the results differ. The findings indicated that conscientiousness positively predicted conditional knowledge while only openness positively predicted debugging skills. However, both openness and conscientiousness positively predicted information management and evaluation of learning (see Table 4).

Table 4

Ordinary Least Squares Regression Results for Personality and Metacognitive Variables from the Costa Rican Sample

Predictor	B^+ ($CI_{95\%}$)	β^-	*t*	*p*
Conditional Knowledge				
Conscientiousness	0.39 (0.20; 0.58)	0.30	3.06	.001**
Debugging				
Openness	0.45 (0.19; 0.63)	0.37	4.02	.001**
Information Management				
Conscientiousness	0.25 (0.09; 0.41)	0.22	2.92	.01**
Openness	0.41 (0.20; 0.62)	0.40	5.26	.001**
Evaluation of Learning				
Conscientiousness	0.28 (0.07; 0.55)	0.24	2.99	.01**
Openness	0.33 (0.16. 0.51)	0.31	4.17	.001**

Note. Only statistically significant results are shown for parsimony. $N = 101$. B^+ = Unstandardized regression coefficients and their 95 % confidence intervals ($CI_{95\%}$). β^- = Standardized regression coefficients. $^{**}p \leq .01$

The omnibus regression model was statistically significant for the Panamanian sample, $F(5,115) = 7.11$, $p < .018$, $R^2 = .296$. Table 5 reports that conscientiousness was a positive predictor of declarative knowledge, and that openness positively predicted conditional knowledge and comprehension monitoring.

Table 5

Ordinary Least Squares Regression Results for Personality and Metacognitive Variables from the Panamanian Sample

Predictor	B^+ ($CI_{95\%}$)	β^-	*t*	*p*
Declarative Knowledge				
Conscientiousness	0.32 (0.14; 0.52)	0.29	2.94	.01**
Conditional Knowledge				
Openness	0.53 (0.20; 0.79)	0.42	6.63	< .001**
Comprehension Monitoring				
Openness	0.38 (0.19; 0.56)	0.34	3.88	.001**

Note. Only statistically significant results are shown for parsimony. $N = 121$. B^+ = Unstandardized regression coefficients and their 95% confidence intervals ($CI_{95\%}$). β^- = Standardized regression coefficients. $^{**}p \leq .01$.

Finally, the omnibus regression model was statistically significant for the Uruguayan sample, $F(5,52) = 5.93$, $p < .023$, $R^2 = .255$. For this sample, the results showed that conscientiousness and openness positively predicted conditional knowledge while only conscientiousness positively predicted debugging and monitoring (Table 6).

Table 6

Ordinary Least Squares Regression Results for Personality and Metacognitive Variables from the Uruguayan Sample

Predictor	B^+ ($CI_{95\%}$)	β^-	*t*	*p*
Conditional Knowledge				
Conscientiousness	0.37 (0.13; 0.60)	0.27	2.61	.01**
Openness	0.31 (0.09; 0.53)	0.24	2.53	.01**
Debugging				
Conscientiousness	0.44 (0.19; 0.70)	0.39	3.84	.01**
Comprehension Monitoring				
Conscientiousness	0.36 (0.08; 0.64)	0.26	2.72	.01**

Note. Only statistically significant results are shown for parsimony. A post-hoc power analysis of the regression model for this country showed an observed power of 0.841, higher than the commonly accepted lower limit value of 0.80. $N = 58$. B^+ = Unstandardized regression coefficients and their 95% confidence intervals ($CI_{95\%}$). β^- = Standardized regression coefficients. $^{**}p \leq .01$.

From these five Latin American samples, despite nuances of both language and culture, openness to new experiences and conscientiousness were consistently the only personality factors that positively predicted conditional knowledge within knowledge of cognition and the five components of regulation of cognition, although this latter pattern differed by culture.

Discussion

The study of metacognition and its importance for students in achieving successful learning has existed since the seminal studies of Flavell (1979, 1987). However, in the current context, metacognition ceases to be an almost exclusive problem about how the learner understands and regulates their own cognitive resources, and instead approaches metacognition as a much more social construct, involving other variables of the learner such as personality, learning preferences, motivation, gender, executive functions, self-concept, and parenting styles, etc. (Gutierrez de Blume & Montoya Londoño, 2022, 2023; Gutierrez Blume et al., 2022; Händel et al., 2020). The objective of this line of research was to establish the relationship between personality factors and metacognition in an intercultural sample of undergraduate students from different Latin American countries. The relationship between some personality factors and the major components of metacognition was supported by the samples from all participating countries. Thus, it is congruent with has been previously reported in studies that have indicated moderate correlations between metacognitive judgments and different personality factors such as openness and extraversion (Buratti & Allwood, 2012; Gutierrez de Blume & Montoya Londoño, 2020, 2023; Kleitman & Stankov, 2007; Nietfeld & Schraw, 2002; Šafranj et al., 2021; Stankov, 2000; 2018; Stankov & Crawford, 1996; 1997). Likewise, significant correlations have been reported between these same personality factors—openness to experience and extraversion—with metacognitive knowledge and regulation (Öz, 2016), and correlations between personality factors and metacognitive judgments (Händel et al., 2020).

Based on the research tradition in the field, metacognition is considered the most effective predictor of learning outcomes (Özçakmak et al., 2021; Swanson et al., 2024; Thiede et al., 2019; Veenman, 2015; Wang et al., 1990). In this regard, various researchers have indicated that students with adequate metacognitive performance in the face of classroom challenges can differentiate what they know from what they do not know, select appropriate strategies to master the learning they do not yet understand, develop goal-based study behavior, establish study plans, evaluate results, and can adjust plans based on the evaluation process they execute. Thus, metacognition allows students to be more efficient in their learning (Bürgler et al., 2022; Celik, 2022; Stanton et al., 2021). In this regard, given the relevance of metacognition for successful academic performance, researchers are making efforts to clarify the criteria that should be considered in any metacognitive intervention, including: 1) metacognitive instruction as part of the class content; 2) informing students about the usefulness and application of metacognitive strategies; and 3) prolonging training over time to ensure the smooth and sustained application of metacognitive performance. However, research on these intervention criteria remains somewhat unexplored, and thus, provide inconclusive results (Azevedo, 2020).

Studies such as the present study represent a contribution to achieving a better explanation of the inconsistent results derived from different intervention research insofar as these differences are plausibly partially due to moderating effects of personality factors. These factors can enhance or limit the possibilities for the student to make more optimal use of the intervention and the opportunities of the metacognitive reflection process. From this perspective, research has demonstrated that metacognitive monitoring accuracy may be influenced by a more global self-concept of ability, associated with relatively stable personality characteristics, rather than actual performance, which may be one reason why monitoring sometimes seems to be a process so resistant to change (Bol et al., 2005; Bol & Hacker, 2001; Dembo & Seli, 2004; Hacker & Bol, 2004; Hacker et al., 2000; Zimmerman & Moylan, 2009).

Likewise, studies conducted outside the classroom, which address the relationship between personality factors (i.e., the Big Five) and the components of metacognition in everyday life (e.g., metacognitive beliefs, metamemory skills, learning judgments, and judgments of the feeling of knowing) during face name recognition tasks, found that people high in neuroticism/low emotional stability showed lower learning and accuracy judgments than people who showed high extraversion. The study concluded that people with neuroticism traits had little confidence in their memory and reported more negative metacognitive beliefs than people with high extraversion (Irak, 2024).

In the present study, with respect to metacognitive knowledge, a relationship was found between declarative and conditional knowledge and openness to experience for all samples from the four countries. This result is interesting, given that knowledge in general is considered the basis of metacognitive regulation of learners. Declarative knowledge allows learners to know themselves, to know the state of their knowledge, and the type of strategies they possess while conditional knowledge allows them to know when, where, why and for what to employ strategies (Brown, 1987; Gutierrez de Blume et al., 2024; Gunstone & Mitchell, 1998; Jacobs & Paris, 1987; Montoya et al., 2024; Moshman, 2017; Schraw & Moshman, 1995; Soleimani et al., 2018). Hence, it is logical that a personality factor such as openness to experience, which implies a disposition towards an active imagination, the ability to reflect on oneself, and intellectual curiosity (Costa & McCrae, 1985; 1992), leads to greater metacognitive knowledge. This implies the knowledge that people have about their own cognition, or about the cognition in general and, especially, about how one learns.

Similarly, metacognitive regulation skills such as planning and monitoring were related to openness and to conscientiousness in the case of the student samples from Argentina, Colombia, Panama, and Uruguay. In this regard, regulation involves the set of skills that allow learners to have a process of anticipation, control, and judgment on the state of learning from some basic subcomponents like planning, information management, monitoring, debugging, and evaluation (Brown, 1987; Gutierrez de Blume et al., 2024; Jacobs & Paris, 1987; Jiménez & Puente, 2014; Montoya et al., 2024; Moshman, 2017; Schraw & Moshman, 1995; Schraw & Dennison, 1994). Conscientiousness or responsibility, likewise, has been understood as the capacity that individuals have towards self-regulated behavior, to act based on the objectives that they planned, and to establish a system of goals, which allow them to organize and execute their objectives (Genise et al., 2020; Lingjaerde et al., 2001). Hence, it may be closely related to regulation skills involved in the planning and monitoring of the learning process, and even in the adjustment of goals or the action plan, if required.

A relationship was also found between other metacognitive regulation skills such as debugging, information management, and evaluation with openness and conscientiousness in the sample from Costa Rica. This can be explained by the type of policies and curricular guidelines given by the Ministry of Public Education (MEP, 2023) of that country, which openly promotes the teaching of metacognition. Moreover, in its latest guidelines for classroom activities, the MEP indicates that, through the evaluation of learning in the country, it seeks to have students self-regulate their learning process, according to their characteristics and interests, in such a way that they experience processes of self-reflection and feedback around the construction of their knowledge (MEP, 2023). This may partially explain why these two personality factors lead to a better regulatory skill.

Finally, openness to experience and conscientiousness lead to better metacognitive performance, especially in relation to the components of declarative and conditional knowledge, and regulation skills, especially at the level of planning and monitoring. These results are consistent with previous research with undergraduate students at the Turkish State University in which openness to experience and conscientiousness have a positive and significant relationship with metacognition (Sapancı & Güler, 2021). Likewise, this result is consistent with the findings of a study conducted with undergraduate students at a university in Scotland, which found that students who showed a high level of conscientiousness, metacognition was a predictor of their academic performance (Kelly & Donaldson, 2016). These findings are highly relevant when considering that aspects such as responsibility and open-mindedness could influence students' ability to plan, organize, evaluate, and adjust their study behavior and to persist in the pursuit of successful performance. In this regard, researchers such as Barrick and Mount (1991) and Britwum et al. (2022) argued that students with a high level of openness to experience are those who have a positive attitude toward deep, complex, and challenging learning experiences, and who tend to be more successful in academic performance.

Conclusions

This study supports the positive relationship between personality factors such as conscientiousness and openness to experience with different types of metacognitive knowledge like declarative and conditional, and with different metacognitive regulation skills, especially planning and monitoring. This was evident in most of the countries included in this research. In contrast, the negative

relationship between neuroticism and metacognitive performance, which has also been described previously in the literature, was not supported.

Of interest is the relationship found between metacognitive regulation skills such as debugging, information management, and evaluation with the personality factors of openness and conscientiousness in the case of the Costa Rican sample. This result can likely be explained by the promotion of different educational policies for working with innovative proposals focused on metacognition, which have been implemented in that country in recent years.

Implications for Theory, Research, and Practice

Research on the relationship between "warm" variables such as personality and "cold" variables such as metacognition contributes to explaining some inconsistent results in many metacognitive intervention programs. It may be a future line of work to expand the current explanation of metacognitive monitoring problems, especially difficulties in monitoring accuracy. As evidenced in the present study, some personality traits such as openness and conscientiousness appear to positively impact metacognitive performance, especially at the level of declarative knowledge, conditional knowledge, planning, and monitoring.

Limitations and New Research Opportunities

The findings of the present study are exploratory and, although the sample size is relatively large compared to other studies of the same nature, future research should replicate this study with larger sample sizes, especially in countries with a small sample size, to ensure that the correlational and predictive pattern that emerged is stable and consistent across multiple samples. The results highlight the need for multicultural studies to investigate the extent to which the results of this study generalize to other cultures, not just those of Latin American countries.

Future research could continue to explore the possible relationship between personality factors and other metacognitive variables of interest. This could include the relationship between personality factors and types of metacognitive judgments, especially at the level of prediction and postdiction judgments. This could also establish possible differences based on the type of task (cognitive, academic, everyday life, etc.), method of assessment (online, offline), method of application (paper and pencil, virtual), and even focusing the analysis on intercultural differences in the relationship between personality, metacognition, and the effect of sociodemographic variables such as gender, years of schooling, or certain differences in the types of educational policies that vary by country.

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