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Cognitive Styles, Motivational Orientations and Learning Processes in University Students

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Abstract. *Based on Curry's¹ three-layered onion model for organizing learning-related conceptualizations, and consistent with her reflections on the role of motivational structures within learning, we integrated cognitive styles and motivational orientations in explaining preferences for learning processes. Cognitive styles (i.e., rational and experiential), motivational orientations (i.e., intrinsic and extrinsic) and learning processes (i.e., deep processing, methodical study, fact retention, elaborative processing) were investigated with self-administered measures among 322 Romanian university students. The relation between constructs was explored through multiple regression analyses and mediation models. Rational cognitive style is associated with all learning processes, while experiential style is not a significant correlate. Extrinsic motivation partially mediates the relation between rational cognitive style and both methodical study and elaborative processing, while intrinsic motivation partially mediates for deep and elaborative processing. Overall, findings support initial assumptions on links between cognitive styles and preferred learning processes, as well as the mediating role of motivational orientations.*

Keywords: learning constructs, intrinsic and extrinsic motivation, mediation models.

Introduction

As suggested by a large body of research², students' individual characteristics like cognitive style, learning style, learning process, and learning strategy are of most relevance in studying academic outcomes. However, as various authors clearly concluded³, overviews of main contributions in this field reveal a

¹ L. Curry, *An organisation of learning styles theory and construct*, Educational Research Information Centre (ERIC) Document No. ED 235 185, 1983.

² See for example: M. Eaves, "The relevance of learning styles for international pedagogy in higher education", in *Teachers and Teaching: theory and practice*, 17 (2011), no. 6, p. 677-691. C. Evans, E. Cools, Z. M. Charlesworth, "Learning in higher education – how cognitive and learning styles matter", in *Teaching in Higher Education*, 15 (2010), no. 4 (2010), p. 467-478. Kateryna Miliutina, Andrii Trofimov, Svitlana Paschenko, Oleksandr Vakulenko, Iuliia Romanova, Nina Rohal, "The use of Projective Methods in working with Staff," in *Astra Salvensis*, VI (2018), no. 11, p. 495-504. C. Evans, M. Waring, "Exploring students' perceptions of feedback in relation to cognitive styles and culture", in *Research Papers in Education*, 26 (2011), no. 2, p. 171-190. A. Valle, R. González, J. C. Núñez, J.A. González-Pienda, "Variables cognitivo-motivacionales, enfoques de aprendizaje y rendimiento académico", in *Psicothema*, 10 (1998), no. 2, p. 393-412.

³ See for example: S. Cassidy, "Learning styles: An overview of theories, models and measures", in *Educational Psychology*, 24 (2004), no. 4 p. 419–444. L. Curry, *An organisation of learning styles theory and construct*. L. Curry, *Integrating Concepts of Cognitive or Learning Style: A Review with Attention to Psychometric Standards*. Ottawa, Canadian College of Health Service Executives, 1987. L. Curry, "A critique of the research on learning styles", in *Educational Leadership*, 48 (1990), no. 2, p. 50-56. M. Kozhevnikov, "Cognitive styles in the context of modern psychology: Toward an integrated framework of cognitive style", in *Psychological Bulletin*, 133 (2007), no. 3, p. 464-481. J. T. E. Richardson, "Approaches to studying, conceptions of learning and learning styles in higher education", in *Learning and Individual Differences*, 21 (2011), no. 3, p. 288–293. R. Riding, I. Cheema,

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plethora of models, concepts and measures related to overlapping constructs, with different backgrounds in terms of research traditions.

The "onion model" proposed by L. Curry⁴ is one of the highly-cited models for organizing various learning style conceptualizations. After reviewing psychometric properties of corresponding measures, especially their test-retest reliability, the author organized learning constructs into three strata arranged from the most context-free elements of learning to the most volatile. The core layer comprises the cognitive style (e.g., reflectivity-impulsivity), the most stable and relatively permanent dimension of the cognitive approach; the middle layer is represented by information processing styles, as described, among others, by Schmeck, Ribich and Ramaniah⁵; the third outermost layer is represented by the interaction with learning environment factors and it refers to instructional preferences (e.g., independent/dependent, collaborative/ competitive). As Curry⁶ argues, this three-step connection between the stable personality strata and the observed behaviour in learning is analogous to the trait-state concept in personality theories⁷.

The present work responds to the need of further empirical exploration of the links between learning-related concepts included in different layers of the onion model⁸ and addresses the relationship between two constructs placed on the inner most and respectively, the middle layer of the model, given Curry's suggestion that constructs in the inner most layer should be essential for the other two layers⁹. In addition, it investigates the contribution of motivational orientation in explaining this hypothetical relationship, based on Curry's¹⁰ reflections on the role of task engagement in activating different styles which are more malleable and permissive to contextual adjustments.

Cognitive Styles and Learning Processes

Cognitive style is an underlying and relatively stable personality level dimension functioning in a trait-like manner, reflecting an individual's approach to adapting and assimilating information. It is a cognitive characteristic that becomes manifest only indirectly and by looking for consistent patterns in functioning across

„Cognitive Styles – an overview and integration", in *Educational Psychology*, 11 (1991), no. 3, p. 193-215. R. Riding, "On the nature of cognitive style", in *Educational Psychology*, 17 (1997), p. 29-49.

⁴ L. Curry, *An organisation of learning styles theory and construct*. L. Curry, *Integrating Concepts of Cognitive or Learning Style: A Review with Attention to Psychometric Standards*. L. Curry, "A critique of the research on learning styles".

⁵ R. R. Schmeck, F. D. Ribich, N. Ramaniah, "Development of a self-report inventory for assessing individual differences in learning processes", in *Applied Psychological Measurement*, 1 (1977), 413-431.

⁶ L. Curry, *An organisation of learning styles theory and construct*.

⁷ See also S. Cassidy, "Learning styles: An overview of theories, models and measures".

⁸ L. Curry, *An organisation of learning styles theory and construct*. L. Curry, *Integrating Concepts of Cognitive or Learning Style: A Review with Attention to Psychometric Standards*.

⁹ L. Curry, *An organisation of learning styles theory and construct*.

¹⁰ L. Curry, "A critique of the research on learning styles".

many cognitive tasks¹¹, while learning style is used to describe the application or usage of a cognitive style into a concrete learning situation¹². In contrast, learning strategies refer to mechanisms not mutually exclusive by which individuals deal with different learning tasks trying to "translate" the given information into a meaningful form according to their cognitive styles¹³. At the intersection of these constructs (i.e., cognitive style and learning strategy) is the information processing style referring to the individual's intellectual approach to assimilating information. While it is not directly dependent on the environmental factors, thus quite stable, it may still be modifiable by learning strategies and learning format choices¹⁴.¹⁵ Cognitive strategies mediate the relationship between the motivation for learning and academic performance.¹⁶ The school has to assume student training in approaching proactive attitudes towards learning, in the formation of a constructivist conception of self - education and self-organizing.¹⁷

The two constructs with their corresponding measures approached in the present study, namely cognitive styles as defined within cognitive-experiential self-theory (CEST¹⁸) and learning processes as information processing styles¹⁹, qualify for association with the inner, respectively the middle layer of the onion model proposed by Curry²⁰. In fact, information processing style is explicitly included by the author in her model, in between cognitive personality styles and instructional preferences.

¹¹ L. Curry, *An organisation of learning styles theory and construct*. L. Curry, "A critique of the research on learning styles". M. Kozhevnikov, "Cognitive styles in the context of modern psychology: Toward an integrated framework of cognitive style". R. Riding, „On the nature of cognitive style".

¹² S. Cassidy, "Learning styles: An overview of theories, models and measures".

¹³ *Ibidem*. L. Curry, *An organisation of learning styles theory and construct*. L. Curry, "A critique of the research on learning styles".

¹⁴ L. Curry, *An organisation of learning styles theory and construct*.

¹⁵ L. Curry, *An organisation of learning styles theory and construct*.

¹⁶ A. D. Manea, "The efficient management of academic learning", in *Studia Universitatis Babeş-Bolyai Psychologia–Pedagogia*, 1(2014), p. 81-89.

¹⁷ A. D. Manea, "Coordinates of Lifelong Education", in *Astra Salvensis*, III (2015), no. 5, p. 168-171.

¹⁸ S. Epstein, R. Pacini, V., Denes-Raj, H. Heier, "Individual differences in intuitive-experiential and analytical-rational thinking styles", in *Journal of Personality and Social Psychology*, 71 (1996), no. 2, p. 390-405. R. Pacini, S. Epstein, "The relation of rational and experiential information processing styles to personality, basic beliefs, and the ratio-bias phenomenon", in *Journal of Personality and Social Psychology*, 76 (1999), no. 6 p. 972–87.

¹⁹ R. R. Schmeck, "Learning styles of college students", in R. Dillon, R. R. Schmeck, (eds) *Individual Differences in Cognition*, New York, Academic Press, 1983, p. 233-279. R. R. Schmeck, F. D. Ribich, N. Ramaniah, "Development of a self-report inventory for assessing individual differences in learning processes". R. R. Schmeck, E. Geisler-Brenstein, E., S. P. Cercy, "Self-Concept and Learning: the revised inventory of learning processes", *Educational Psychology*, 11 (1991), no. 3, p. 343-362. R. R. Schmeck, F. D. Ribich, "Construct Validation of the Inventory of Learning Processes", in *Applied Psychological Measurement*, 2 (1978), no. 4, p. 551-562.

²⁰ L. Curry, *An organisation of learning styles theory and construct*. L. Curry, *Integrating Concepts of Cognitive or Learning Style: A Review with Attention to Psychometric Standards*. L. Curry, "A critique of the research on learning styles".

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Cognitive-experiential self-theory (CEST²¹) distinguishes between rational and experiential cognitive styles which provide, in a broad sense, the background for individual differences in whether people typically respond primarily rationally or intuitively to decision situations. Therefore, rational and experiential styles may be described as two general dimensions of the cognitive personality²². The rational system is mainly inferential and operates by a persons' understanding of culturally transmitted rules of reasoning, whereas the experiential system is preconscious, rapid, automatic, holistic, primarily nonverbal and intimately associated with affect²³. There is a need to increase learning efficiency through: adequate time management, implementation of the learning plan, hygiene and ergonomics of learning space.²⁴

Learning processes are defined in close relation with information processing theories and aim to address culture-faire universal learning mechanisms²⁵. They address "individual's intellectual approach to assimilating information following the information processing model"²⁶ and are rather stable, as they may be placed in between cognitive styles and instructional preferences. One of the information processing models of learning style covered in comprehensive frameworks²⁷ was elaborated on by Schmeck, Ribich and Ramaniah²⁸ (1977) and focuses on quality of thinking which influences "the distinctiveness, transferability and durability of memories that resulted from the learning event"²⁹ and affects the way individuals tackle a learning task, regardless its characteristics. Thus, learning processes may be also referred as generalized patterns of information processing.

²¹ S. Epstein, "Cognitive-experiential self-theory", in L. Pervin (ed.), *Handbook of personality theory and research*, New York, Guilford, 1990, p. 165-192. S. Epstein, "Integration of the cognitive and the psychodynamic unconscious", in *American Psychologist*, 49 (1994), p. 709-724. S. Epstein, "Intuition from the perspective of cognitive-experiential self-theory", in H. Plessner, C. Betsch, T. Betsch (eds.), *Intuition in judgment and decision making*. New York, Erlbaum, 2008, p. 23-37. S. Epstein, R. Pacini, V., Denes-Raj, H. Heier, "Individual differences in intuitive-experiential and analytical-rational thinking styles".

²² R. Pacini, S. Epstein, "The relation of rational and experiential information processing styles to personality, basic beliefs, and the ratio-bias phenomenon".

²³ O. Blazhenkova, M. Kozhevnikov, "The new object-spatial-verbal cognitive style model: theory and measurement", in *Applied Cognitive Psychology*, 23 (2009), p. 638-663.

²⁴ A. D. Manea, "The efficient management of academic learning, în *Studia Psychologica- Pedagogia*, 1(2014), p. 81-89.

²⁵ J. B. Biggs, D., Kember, D. Y. P. Leung, "The Revised Two Factor Study Process Questionnaire: R-SPQ-2F", in *British Journal of Educational Psychology*, 71 (2001), p. 133-149.

²⁶ L. Curry, *An organisation of learning styles theory and construct*, p. 8.

²⁷ S. Cassidy, "Learning styles: An overview of theories, models and measures". L. Curry, *An organisation of learning styles theory and construct*. S. G. Rayner, „Reconstructing style differences in thinking and learning: profiling learning performance", in R. Riding, S. G. Rayner (eds.), *International perspectives on individual differences. Volume 1: Cognitive styles*, Stamford, Connecticut, Ablex Publishing Corporation, 2000, p. 115-178.

²⁸ R. R. Schmeck, F. D. Ribich, N. Ramaniah, "Development of a self-report inventory for assessing individual differences in learning processes".

²⁹ S. G. Rayner, „Reconstructing style differences in thinking and learning: profiling learning performance".

Schmeck, Ribich and Ramaniah³⁰ originally described four types of learning processes: synthesis-analysis, elaborative processing, fact retention, and study methods. *Synthesis-analysis* orientation in information-processing (subsequently renamed *deep processing*³¹) refers to semantic or categorical judgments elaborated on by individuals when approaching new information, through tactics as searching out, comparing and contrasting different sources of information, extracting new concepts, critically evaluating and hierarchically organising concepts³². *Elaborative processing* may be explained as the tendency to take an active rather than a passive role in processing of new information and covers behaviours involving association of new and old information, using visual imagery, rephrasing in one's own words, imagining practical applications. *Fact retention* captures orientation to details and specifics as opposed to generalities. Individuals approach new pieces of information and store them differently, regardless other information-processing orientation. *Study methods* or *methodical study*, as referred to in later works³³, indicates the use of systematic, traditional study techniques for learning in academic contexts and was positively related to academic performance in the intentional condition of the verbal learning study³⁴.

Integrating Motivational Orientations in Between Cognitive Styles and Learning Processes

Success in academic tasks requires both specific information processing habits and a positive motivation³⁵. The informatized society of the future needs the development of the digital competences at all levels in the educational communities, which means responsibility and self - responsibility for the educational institutions and for the educators.³⁶ Even if cognitive and information processing styles are personal cognitive presets somehow implicitly present in a learning situation, "task-relevant cognitive processing or cognitive control would not be likely unless adequate task engagement was maintained" via positive motivation³⁷. Sternberg³⁸ also argues that cognitive styles should count as much as

³⁰ R. R. Schmeck, F. D. Ribich, N. Ramaniah, "Development of a self-report inventory for assessing individual differences in learning processes".

³¹ R. R. Schmeck, "Learning styles of college students".

³² R. R. Schmeck, F. D. Ribich, N. Ramaniah, "Development of a self-report inventory for assessing individual differences in learning processes". R. R. Schmeck, E. Geisler-Brenstein, E., S. P. Cery, "Self-Concept and Learning: the revised inventory of learning processes".

³³ R. R. Schmeck, E. Geisler-Brenstein, E., S. P. Cery, "Self-Concept and Learning: the revised inventory of learning processes".

³⁴ R. R. Schmeck, F. D. Ribich, N. Ramaniah, "Development of a self-report inventory for assessing individual differences in learning processes".

³⁵ E. A. Linnenbrink, P. R. Pintrich, "Motivation as an enabler of academic success", in *School Psychology Review*, 31 (2002), no. 3 p. 313-327.

³⁶ A. D. Manea, C. Stan, "Study regarding the use of information and communications technology", in *The European Proceedings of Social & Behavioural Sciences. Conference: Education, Reflection, Development*, 33 (2017), p. 271-277.

³⁷ L. Curry, "A critique of the research on learning styles", p. 7.

³⁸ R. J. Sternberg, *Thinking styles*, Cambridge, Cambridge University Press, 2009.

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motivation and ability in orienting a person towards certain activities. Studies additionally emphasize the role of intrinsic motivation in learning processes: intrinsically motivated students engage actively in learning activities, and therefore achieve better³⁹.

Busato, Prins, Elshout and Hamaker⁴⁰ pursued a connection between learning styles, main personality traits and achievement motivation among university students. Their results showed that meaning, reproduction and application directed learning styles are positively correlated with achievement motivation and academic performance. Although constructs measured in their studies were more likely learning strategies and not learning styles (according to the conceptual distinctions previously presented in this paper), we acknowledge the importance of studying the relation between cognitive and motivational aspects in learning situations. The relationships between cognitive styles and achievement motivation are also reported in a study conducted by Fan and Zhang⁴¹ among Chinese university students. Their findings support the positive correlation of complex thinking styles with achievement motivation to approach success, and negative correlation with the achievement motivation to avoid failure. However, expected correlations between more simplistic thinking styles and achievement motivation are partially supported in their data.

In a similar vein is the study conducted by Rosario et al.⁴² within the framework of Biggs' 3P model on academic learning, postulating that presage variables (prior knowledge, ability, preferred approach to learning) influence those of product (academic outcomes), mediated by process variables. What is of main interest here is that, among multiple variables considered in their complex investigation, the authors included the thinking styles in the presage variables group and motivation (deep, superficial) as process variables influencing the learning processing (deep, superficial) as proposed by Biggs. Their results showed that the executive-conservative thinking style positively influences superficial motivation and superficial strategies and negatively relates to deep motivation, while the

³⁹ J. Reeve, E. L. Deci, R. M. Ryan, "Self-determination theory: a dialectical framework for understanding sociocultural influences on student motivation", in D. M. McInerney, S. Van Etten (eds.), *Big theories revisited. Research on sociocultural influences on motivation and learning*, Volume 4, Greenwich, Connecticut, Information Age Publishing, 2004, p. 31-60. J. Reeve, R. Ryan, E. Deci, H. Jang, "Understanding and promoting autonomous self-regulation: a self-determination perspective", in D. Schunk, B. Zimmerman (eds.), *Motivation and self-regulated learning: theory, research, and applications*, London, LEA, 2008, p. 223-244.

⁴⁰ V. V. Busato, F. G. Prins, J. J. Elshout, C. Hamaker, "The relation between learning styles, the Big Five personality traits and achievement motivation in higher education", in *Personality and Individual Differences*, 26 (1999), p. 129- 40. V. V. Busato, F. G. Prins, J. J. Elshout, C. Hamaker, "Intellectual ability, learning style, personality, achievement motivation and academic success of psychology students in higher education", in *Personality and Individual Differences*, 29 (2000), 1057-1068.

⁴¹ W. Fan, L. F. Zhang, "Are achievement motivation and thinking styles related? A visit among Chinese university students", in *Learning and Individual Differences*, 19(2009), p. 299-303.

⁴² P. Rosário, J. C. Núñez, J. A. González-Pienda, L. Almeida, S. Soares, M. Rubio, "El aprendizaje escolar examinado desde la perspectiva del «Modelo 3P» de J. Biggs", in *Psicothema*, 17 (2005), no. 1, p. 20-30.

judicial-liberal style has a positive significant influence on deep motivation and deep processing and a negative effect on superficial motivation. Motivation types are also convergent with the corresponding learning processing. But again, the construct approached in this study is closer to learning strategy than learning process as reflected in Curry's "onion" model⁴³.

Research Objectives and Hypotheses

Several works attempted to empirically test Curry's⁴⁴ onion model either directly⁴⁵, or indirectly in the processes of validating research measures⁴⁶, but the model is yet not well researched, as pointed out by Zhang and Sternberg⁴⁷. The efforts to research the model targeted either styles stability or their overlaps, but did not reach clear conclusions. Thus, Cools and Bellens⁴⁸ concluded their work with mixed results: data did not fully support the causal relation from constructs of the inner layers over constructs of the outer layers and ultimately to learning outcomes, and changes over time were significant for both cognitive styles and learning constructs related to the middle and outermost layer. Therefore, they call for additional research on the assumptions supporting the onion model⁴⁹ and caution on its potential limitations.

The present study aims to add empirical evidence on the relation between learning constructs placed by Curry on different layers, but also to explore the role of additional constructs in explaining it. Specifically, we integrate rational and experiential cognitive styles⁵⁰ and motivational structures (intrinsic and extrinsic motivation⁵¹) in explaining preferences for learning processes as defined by Schmeck et al.⁵².

Accordingly, we hypothesised a significant relation between rational cognitive style, primarily based on reasoning⁵³, and learning processes defined as

⁴³ L. Curry, *An organisation of learning styles theory and construct*. L. Curry, *Integrating Concepts of Cognitive or Learning Style: A Review with Attention to Psychometric Standards*.

⁴⁴ L. Curry, *An organisation of learning styles theory and construct*.

⁴⁵ See for example: E. Cools, K. Bellens, "The onion model: Myth or reality in the field of individual differences psychology?", in *Learning and Individual Differences*, 22 (2012), no. 4, p. 455-462.

⁴⁶ See for example: J. Beyler, R. R. Schmeck, "Assessment of individual-differences in preferences for holistic-analytic strategies – evaluation of some commonly available instruments", in *Educational and psychological measurement*, 52 (1992), no. 3, p. 709-719.

⁴⁷ L.-F. Zhang, R. J. Sternberg, R. J., *The nature of intellectual styles*, New York, Routledge, 2011.

⁴⁸ E. Cools, K. Bellens, "The onion model: Myth or reality in the field of individual differences psychology?"

⁴⁹ L. Curry, *An organisation of learning styles theory and construct*.

⁵⁰ R. Pacini, S. Epstein, "The relation of rational and experiential information processing styles to personality, basic beliefs, and the ratio-bias phenomenon".

⁵¹ T. M. Amabile, K. G. Hill, B. A. Hennessey, E. M. Tighe, "The Work Preference Inventory: Assessing Intrinsic and Extrinsic Motivational Orientations", in *Journal of Personality and Social Psychology*, 66 (1994), no. 5, p. 950-967.

⁵² R. R. Schmeck, F. D. Ribich, N. Ramaniah, "Development of a self-report inventory for assessing individual differences in learning processes".

⁵³ R. Pacini, S. Epstein, "The relation of rational and experiential information processing styles to personality, basic beliefs, and the ratio-bias phenomenon".

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generalized patterns of information processing⁵⁴, while the experiential style which is mainly intuitive was expected to display weak association with these constructs. Motivational structures were expected to mediate the relation between the two sets of individuals' cognitive characteristics, placed at the inner and middle layer of the model.

Methods

Participants. Participants were 322 undergraduate students in humanities and social sciences from a large public university (252 females and 70 males), with ages ranging from 19 to 24 ($M= 20.40$, $SD= 0.87$). Participation was entirely voluntary and anonymity was guaranteed.

Measures. *Rational-Experiential Inventory* developed based on CEST (REI⁵⁵) was applied for assessing students' cognitive styles. It includes 40 items using 5-point ratings (from 1, definitely not true of myself, to 5, definitely true of myself), distributed in two main scales (rational and experiential styles). Average scores for the scales were used for analyses. With its both scales exhibiting good internal consistencies and test-retest reliabilities⁵⁶, the REI meets the stability criterion proposed by Curry⁵⁷.

The *Inventory of Learning Processes* (ILP⁵⁸) includes 62 items in true-false format, grouped in four subscales: deep processing, methodical study, fact retention and elaborative processing. As both internal consistency and test-retest reliability coefficients show⁵⁹, the ILP also meets the stability criterion proposed by Curry.

Work Preference Inventory (WPI⁶⁰) was used in order to assess individual differences in intrinsic and extrinsic motivational orientations among university students. The inventory includes 30 items with a four-point Likert-type response (never to always), assigned to two primary scales (intrinsic and extrinsic motivational orientations) Average scores were used for each scale.

All instruments were adapted for the present study, with all scales showing good levels of internal consistency (see Table 1).

⁵⁴ R. R. Schmeck, F. D. Ribich, N. Ramaniah, "Development of a self-report inventory for assessing individual differences in learning processes".

⁵⁵ R. Pacini, S. Epstein, "The relation of rational and experiential information processing styles to personality, basic beliefs, and the ratio-bias phenomenon".

⁵⁶ See also: A. D. G. Marks, D. W. Hine, R. L. Blote, W. J. Phillips, "Assessing individual differences in adolescents' preference for cognition", in *Personality and Individual Differences*, 44 (2008), p. 42–52.

⁵⁷ L. Curry, *An organisation of learning styles theory and construct*.

⁵⁸ R. R. Schmeck, F. D. Ribich, N. Ramaniah, "Development of a self-report inventory for assessing individual differences in learning processes". R. R. Schmeck, F. D. Ribich, "Construct Validation of the Inventory of Learning Processes".

⁵⁹ See also: S. Carnicom, M. Clump, "Assessing the learning style differences between honors students and non-honors students", in *Journal of the National Collegiate Honors Council*, 138 (2004), p. 36-44.

⁶⁰ T. M. Amabile, K. G. Hill, B. A. Hennessey, E. M. Tighe, "The Work Preference Inventory: Assessing Intrinsic and Extrinsic Motivational Orientations".

Procedure. Questionnaires were administered in paper-and-pencil format with written instructions. Students completed the questionnaires in group format and received course credits for participation.

Data analysis. Pearson's product-moment correlation was used in the preliminary analyses to examine the relationship between the variables, followed by hierarchical regressions. The PROCESS procedure for SPSS (Release 2.041⁶¹) was used to test the mediation models. Confidence intervals that do not contain zero indicate a significant indirect effect (mediation). In each mediation model, 1 000 bootstrap resamples were used to estimate the confidence intervals.

Results

Descriptive statistics and correlations between measures are reported in Table 1. Rational cognitive style is related to all four types of learning processes investigated in the study. No significant correlations were found between experiential cognitive style and learning processes. Except for fact retention, all types of learning processes are positively related with intrinsic motivation, and negatively with extrinsic motivation. Also, rational cognitive style correlates positively with intrinsic motivation and negatively with extrinsic motivation.

Table 1. Scale means, reliability coefficients, and correlations ($N= 322$)

Variables	M	SD	1	2	3	4	5	6	7	8
1. Deep processing	13.10	3.53	.76							
2. Methodical study	12.27	4.02	.49**	.81						
3. Fact retention	4.30	1.47	.31**	.36**	.70					
4. Elaborative processing	10.52	2.58	.60**	.48**	.15**	.70				
5. Rational style	3.69	0.51	.58**	.32**	.13*	.49**	.77			
6. Experiential style	3.34	0.50	.10	-.06	.07	-.02	.04	.75		
7. Intrinsic motivation	3.11	0.38	.41**	.27**	.02	.36**	.55**	.14*	.78	
8. Extrinsic motivation	2.62	0.52	-.20**	-.24**	-.06	-.25**	-.27**	.06	-.15**	.82

Note: * $p < .05$; ** $p < .01$. Reliabilities are provided along the diagonal.

Based on the significant correlations found, multiple mediation analyses, with intrinsic and extrinsic motivation as mediators, were performed to investigate indirect effect of rational cognitive style on three types of learning processes (deep processing, study method and elaborative process). Table 2 presents results using multiple regression analysis and the bootstrap method.

⁶¹ K. J. Preacher, A. F. Hayes, "Contemporary approaches to assessing mediation in communication research", in A. F. Hayes, M. D. Slater, L. B. Snyder (eds), *The Sage sourcebook of advanced data analysis methods for communication research*, Thousand Oaks, CA, Sage Publications, 2008, p. 13-54. A. F. Hayes, PROCESS: *A versatile computational tool for observed variable mediation, moderation, and conditional process modeling* [White paper], 2012. Retrieved from <http://www.afhayes.com/public/process2012.pdf>, accessed in April 2016.

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Results show significant direct effects between rational cognitive style and deep processing (B= 4.00, $p < .001$), methodical study (B= 2.52, $p < .001$) and elaborative processing (B= 2.48, $p < .001$), prior to controlling for intrinsic and extrinsic motivation. Controlling for intrinsic and extrinsic motivation, the direct effect between rational cognitive styles and deep processing (B= 3.41, $p < .001$), methodical study (B= 1.63, $p < .001$) and elaborative processing (B= 1.96, $p < .001$) were reduced, but still remain significant.

Significant indirect effects of rational style were found, partly mediated through intrinsic and/ or extrinsic motivation. All indirect effects are reported in Table 2. There were significant indirect effects on deep processing through intrinsic motivation (bootstrap mean= .50, 95%CI= .09-.92) and non-significant through extrinsic motivation (bootstrap mean= .09, 95%CI= -.07-.28).

There were significant indirect effects on methodical study through extrinsic motivation (bootstrap mean= .34, 95%CI=.10-.65) and non-significant through intrinsic motivation (bootstrap mean= .55, 95%CI= -.13-1.17).

There also were significant indirect effects on elaborative processing through intrinsic motivation (bootstrap mean= .35, 95%CI= .06 -.70) and extrinsic motivation (bootstrap mean= .17, 95%CI=.04 -.36).

Table 2. Regression and bootstrap results for intrinsic and extrinsic motivation as mediators

Regression model	Regression			R ²	ΔR^2	Bootstrap		
	B	SE	B			Indirect effect	SE	95% CI
Deep processing								
Step 1				.34				
Rational style	4.00**	.31	.58**					
Step 2				.35	.01*			
Rational style	3.41**	.38	.50**					
Intrinsic motivation	1.21*	.50	.13*			.50	.21	.09-.92
Extrinsic motivation	-.32	.32	-.05			.09	.09	-.07-.28
Methodical study								
Step 1				.10				
Rational style	2.52**	.42	.32**					
Step 2				.14	.04**			
Rational style	1.63**	.50	.21**					
Intrinsic motivation	1.32*	.65	.13*			.55	.32	-.13-1.17
Extrinsic motivation	-1.24**	.42	-.16**			.34	.14	.10-.65
Elaborative processing								
Step 1				.24				
Rational style	2.48**	.25	.49**					
Step 2				.27	.03**			
Rational style	1.96**	.30	.39**					
Intrinsic motivation	.84*	.39	.13*			.35	.16	.06-.70
Extrinsic motivation	-.63*	.25	-.13*			.17	.08	.04-.36

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

Discussion and Conclusions

Although extensive empirical effort have been invested in connecting various learning constructs, types of linkages between cognitive styles, learning processes and motivational orientations were approached sequentially, mainly in close relation with academic performance. While some studies include learning styles and achievement motivation among other individual variables in explanatory models of academic outcomes⁶², others emphasize the role of motivational structures⁶³. As previously mentioned, there are also more complex research designs exploring the influence of various variables (cognitive, motivational, personal characteristics, task-related elements) on the academic outcomes⁶⁴. However, as we already argued, if we take a closer look at the measures used, the emphasis in these studies was mainly on the ongoing learning strategies or approaches, rather than on cognitive styles and processes as defined by various authors in their theoretical and conceptual systematization efforts⁶⁵.

The present study considered cognitive style and motivational orientations in explaining learning processes. As our results show, rational cognitive style is strongly associated with deep and elaborative processing, moderately correlates with methodical study and it is weakly associated with fact retention, while experiential style was not identified as a significant correlate for any of the learning processes. Pacini and Epstein⁶⁶ defined rational and experiential cognitive styles by contrast, but individuals use both cognitive styles interactively⁶⁷ in solving tasks which may be primarily rational or intuitive⁶⁸. As learning processes covered in our study are essentially rational and voluntarily processes employed during conscious

⁶² V. V. Busato, F. G. Prins, J. J. Elshout, C. Hamaker, "The relation between learning styles, the Big Five personality traits and achievement motivation in higher education". V. V. Busato, F. G. Prins, J. J. Elshout, C. Hamaker, "Intellectual ability, learning style, personality, achievement motivation and academic success of psychology students in higher education".

⁶³ F. Doménech-Betoret, A. Gómez-Artiga, "The relationship among students' and teachers' thinking styles, psychological needs and motivation", in *Learning and Individual Differences*, 29 (2014), p. 89-97. W. Fan, L. F. Zhang, "Are achievement motivation and thinking styles related? A visit among Chinese university students".

⁶⁴ See for example: P. Rosário, J. C. Núñez, J. A. González-Pienda, L. Almeida, S. Soares, M. Rubio, "El aprendizaje escolar examinado desde la perspectiva del «Modelo 3P» de J. Biggs".

⁶⁵ S. Cassidy, "Learning styles: An overview of theories, models and measures". L. Curry, *An organisation of learning styles theory and construct*. L. Curry, *Integrating Concepts of Cognitive or Learning Style: A Review with Attention to Psychometric Standards*. L. Curry, "A critique of the research on learning style". M. Kozhevnikov, "Cognitive styles in the context of modern psychology: Toward an integrated framework of cognitive style". J. T. E. Richardson, "Approaches to studying, conceptions of learning and learning styles in higher education". R. Riding, „On the nature of cognitive style". R. Riding, I. Cheema, "Cognitive Styles – an overview and integration".

⁶⁶ R. Pacini, S. Epstein, "The relation of rational and experiential information processing styles to personality, basic beliefs, and the ratio-bias phenomenon".

⁶⁷ See for example: J. S. B. T. Evans, "Dual-processing accounts of reasoning, judgment, and social cognition", *Annual Review of Psychology*, 59 (2008), p. 255–278. R. M. Hogarth, "Deciding analytically or trusting your intuition? The advantages and disadvantages of analytic and intuitive thought", in T. Betsch, S. Haberstroh (eds.), *The routines of decision making*, Mahwah, NJ, Erlbaum, 2005, p. 67-82.

⁶⁸ C. Wittman, C., J. van den Bercken, L. Claes, A. Godoy, "Assessing rational and intuitive thinking styles", *European Journal of Psychological Assessment*, 25 (2009), no. 1, p. 39–47.

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learning tasks⁶⁹, they correlate significantly only with the rational cognitive style, as hypothesized. Furthermore, the very weak relation between fact retention and rational style is not surprising, being explained by the less active elaborative nature of this learning process. These first findings support initial assumptions on links between cognitive styles and learning processes, based on constructs' differentiation in the onion model⁷⁰.

Given the importance of motivational orientation in triggering task-relevant cognitive processing and task cognitive engagement⁷¹, we were also interested in testing the mediating role of intrinsic and extrinsic on the abovementioned relations between cognitive constructs. As shown extrinsic motivation partially mediates the relation between rational cognitive style and both methodical study and elaborative processing, while intrinsic motivation partially mediates for deep and elaborative processing. These results indicate that, in learning contexts, the translation of a dominant rational cognitive style into an active, deep, elaborative information processing is enhanced by individuals' intrinsic motivation. Additionally, a more dominant rational style reduces extrinsic motivation leading to a higher tendency to engage in methodical study process, which, despite its more algorithmic and conventional nature, is still positively related to academic performance⁷². Thus, the initial assumption of our study based on Curry's suggestion and on previous empirical studies⁷³, that motivational structures may mediate the relation between cognitive styles and learning processes is supported by the data.

Overall, the present work supports to a great extent the relation between cognitive styles and learning processes, the two constructs related with the inner and middle layer of Curry's onion model⁷⁴, and the mediation through motivational orientations. It also provides additional empirically-based information for the links between constructs, and answers the need to explore one of the most cited theoretical models attempting to order, clarify and integrate learning-related concepts, as advocated in both review studies⁷⁵ and empirical evaluations⁷⁶.

⁶⁹ R. R. Schmeck, F. D. Ribich, N. Ramaniah, "Development of a self-report inventory for assessing individual differences in learning processes". R. R. Schmeck, F. D. Ribich, "Construct Validation of the Inventory of Learning Processes".

⁷⁰ S. Cassidy, "Learning styles: An overview of theories, models and measures". L. Curry, *An organisation of learning styles theory and construct*. L. Curry, *Integrating Concepts of Cognitive or Learning Style: A Review with Attention to Psychometric Standards*. L. Curry, "A critique of the research on learning styles".

⁷¹ L. Curry, "A critique of the research on learning styles". R. J. Sternberg, *Thinking styles*.

⁷² R. R. Schmeck, F. D. Ribich, N. Ramaniah, "Development of a self-report inventory for assessing individual differences in learning processes".

⁷³ See for example: P. Rosário, J. C. Núñez, J. A. González-Pienda, L. Almeida, S. Soares, M. Rubio, "El aprendizaje escolar examinado desde la perspectiva del «Modelo 3P» de J. Biggs".

⁷⁴ L. Curry, *An organisation of learning styles theory and construct*. L. Curry, *Integrating Concepts of Cognitive or Learning Style: A Review with Attention to Psychometric Standards*. L. Curry, "A critique of the research on learning styles".

⁷⁵ See for example: L.-F. Zhang, R. J. Sternberg, *The nature of intellectual styles*.

⁷⁶ See for example: E. Cools, K. Bellens, "The onion model: Myth or reality in the field of individual differences psychology?".

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However, the cross-sectional design of our study may offer information only for the relation between the constructs and not for constructs malleability or stability. In the light of the present research results, we argue that beyond reasonable caution the onion model should be further evaluated in both cross-sectional and longitudinal studies. Although more complex research integrating all layers of the model and also considering longitudinal perspective may be more fruitful for complete evaluation, studies attempting sections of the model may also contribute to the larger debate on its empirical grounds, especially given the scarcity of such studies.

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