







Developmental Psychology

Psychometric Properties of the Spanish Version of the Complex Postformal Thought Questionnaire: Developmental Pattern and Significance and Its Relationship With Cognitive and Personality Measures

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Postformal thought is the highest state of thinking in adults, extending beyond formal operations. Sinnott's Complex Postformal Thought Questionnaire (PFTQ) is one of the most widely used measures of this construct and thus, the main aim of this study was to translate a Spanish version of the PFTQ and to validate it using a sample of 1093 subjects aged from 18 to 71 years. A cross-validation study was carried out and measurement invariance was analyzed by gender and across age groups: emerging adults, 18-29 years; established adults, 30-45 years; and middle-aged adults, 46-60 years. Furthermore, evidence of validity was assessed relative to cognitive and personality measures (i.e.: mindfulness, grit, resilience, intolerance of uncertainty, conscientiousness, metacognition and learning strategies), as was the developmental pattern of the PFTQ. In the cross-validation study, both the exploratory and confirmatory factor analyses indicated it was appropriate to consider a unidimensional structure. Likewise, the PFTQ exhibited good psychometric properties ($\alpha = .84$; $\Omega = .83$), and there was reasonable evidence of strict invariance by gender and across age groups. Moreover, the PFTQ was significantly and positively related to metacognition, learning strategies, mindfulness, conscientiousness, resilience and grit, whereas it was significantly and negatively related to intolerance of uncertainty, albeit to a lesser extent. Finally, a developmental progression of the PFTQ was observed during adulthood, with significant differences observed between the latent means of the three age groups, which was associated with moderate effect sizes between the emerging and the established or middle-age adult groups ($d = 0.28$ and $d = 0.37$, respectively). By contrast, a very small and practically negligible effect size was detected between the established and middle-aged adult groups ($d = 0.09$). Relativistic operations would appear to underlie psychosocial development in established adulthood, when they are most needed. Overall, the Spanish version of the PFTQ showed good psychometric properties and validity evidence of its utility to studying adult thinking.

Piaget's theory is undoubtedly a milestone in the study of human development. The stage of formal operations (Inhelder & Piaget, 1955) is the last of his theory and it involves adolescent's deploying hypothetical-deductive reasoning as a scientist would. Although Piaget claimed that formal operations constitute the pinnacle of cognitive de-

velopment, formal thinking has been criticized (Keating, 1990) for its inadequacy in addressing various crucial task demands (Commons & Ross, 2008; Sinnott, 1998), and its inability to explain the necessary adaptations to the demands and pragmatic concerns of adulthood (Sinnott & Johnson, 1997; see also Kallio, 2015; Riegel, 1973; Sinnott,

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1998). Since the 1970s, attention has shifted from attempts to explain the development of logic to *what is the logic of development* (Labouvie-Vief, 1980). As a result, several authors proposed the existence of novel qualitative intellectual development during adulthood and aging, namely postformal thought (hereafter PFT: Basseches, 1980; Commons et al., 1982; Kramer, 1983; Labouvie-Vief, 1982; Riegel, 1973; Sinnott, 1981, 1998), which extends beyond formal operations and focuses on gains, progression and potential, in contrast to age-related intellectual decline (Labouvie-Vief & Diehl, 2000).

Overall, PFT implies the highest stage of thinking in adults, a new *way of reading* the world that embraces transdisciplinary thinking (McGregor, 2014). Moreover, PFT is unrelated to intelligence as assessed by IQ tests (Sinnott et al., 2016) but rather, bridges cognition and emotion, as well as the self and others (Sinnott, 1998). However, we currently lack a unified and robust conceptualization of postformal approaches (Jory et al., 2018). In fact, the definition of the common features of PFT four decades ago (Kramer, 1983) is still referred to and is that which is accepted today. Thus, the first aspect that defines PFT is the relativistic nature of knowledge. Actually, truths are associated with a given context, i.e.: a specific observer at a given time and place (McGregor, 2014). Likewise, the extent to which knowledge is influenced by context changes constantly, and its subjective nature is evident. In line with this, relativistic thinking is most useful in ill-structured situations that lack clear goals and that frequently arise in everyday life (Sinnott, 1998), making such thinking adaptive, ecologically valid, and focused on utility and pragmatism (Gurba, 2005; Sinnott, 1981; P.-L. Wu & Chiou, 2008). A second key feature of PFT is the acceptance of contradiction and integration into the dialectical whole, the latter being emphasized by the postformal dialectical thinking. In this regard and significantly, relativistic thinking would *only* describe the first sub-stage of PFT (Blouin & McKelvie, 2012; Wynn et al., 2014, 2016). Thus, dialectical thinking includes relativistic thinking but it goes further by recognizing the unity that underlies the opposites that are part of a whole (Kramer et al., 1992; see also Basseches, 2005). It is therefore understandable that relativistic-dialectical thinking has traditionally been considered a synonym of PFT.

The importance of PFT is also understood insofar as it can be used in a wide variety of contexts (Pearson et al., 2018; Sinnott et al., 2017), with obvious implications for adaptation to real-life dynamics (Chiou, 2008) within oneself, in terms of social interactions and even those with a transcendent figure (Sinnott, 2009). Furthermore, PFT offers multiple benefits for science, technology, mathematics, humanities, successful management, and innovation (Commons et al., 2008; Commons & Ross, 2008), and its growing importance is also reflected in the interest in finding the neural correlates underlying such thought (Leite et al., 2016). In line with the above, much research has been conducted to both empirically validate the existence of postformal operations (see reviews such as Gurba, 2005; Kallio, 2011; Marchand, 2002), and to analyze the relationship of

PFT to important and diverse areas of daily functioning (see Cartwright, 2001; Chang & Chiou, 2014; Day, 2010, 2017; Galupo et al., 2010; Griffin et al., 2009; Han & Bai, 2020; Jennings et al., 2009; Jory et al., 2018; Morton et al., 2000; Sinnott, 2001; Sinnott & Johnson, 1997; Weitzman & Weitzman, 2006).

Jan D. Sinnott's theory and the Complex Postformal Thought Questionnaire (PFTQ)

Among the main theories of PFT is that of Jan D. Sinnott, who developed the relativistic stage. Her theory of PFT stipulates the existence of individual high-level mental processes or *operations* that describe core qualitative aspects of PFT and which make relativistic thinking possible. These relativistic operations represent “the world in full and nuanced ways” (Sinnott et al., 2017, p. 244), and their conscious use enables the individual to find efficient solutions in interpersonal and everyday situations (Sinnott, 1984). These operations are: paradox; multiple methods; parameter setting; problem definition; process/product shift; metatheory shift; multiple causality; multiple solutions; multiple goals; and pragmatism.

The essence of the postformal operations in Sinnott's framework are both self-reference (or “necessary subjectivity”) and they involve the ordering of conflicting logic or systems of truth (Sinnott, 1989b, 1998, 2001, 2010; Sinnott et al., 2017; see also Cartwright, 2001). Thus, the individual realizes that there are many logical systems, that may even be logically contradictory and yet internally consistent. In the end, a logical system is chosen subjectively, such that “truth” is partially generated by making “a decision about rules of the game (about the nature of truth)” (Sinnott, 2010, p. 238). This choice definitively allows the individual to get on with his or her life. Accordingly, Sinnott's theory includes not only relativistic thinking but also, an acceptance and synthesis of contradiction (Cavanaugh et al., 1985; Kramer, 1983). Thus, a parallelism exists between dialectical thinking and relativistic operations (Kramer & Melchior, 1990), such that relativistic operations would facilitate “consensus understanding and maximal use of conflicting information” (Sinnott, 1984, p. 320). This makes Sinnott's explanation of the development of thought in adulthood robust. Moreover, to the extent that relativistic operations are everyday tools to resolve ill-defined situations, and that they also constitute a way of making sense of the practical demands and concerns of adult life (Stähle et al., 2020), they potentially lay down the foundations to resolve vital tasks in adult life. Therefore, continuing to study the scope and usefulness of such operations is still justified, constituting the foundation of the current study.

Sinnott also developed a tool commonly used to measure PFT, the Complex Postformal Thought Questionnaire (PFTQ: Sinnott, 1998, 2008; Sinnott et al., 2016, 2017; Sinnott & Johnson, 1997). The PFTQ is a paper-and-pencil questionnaire that is composed of 10 items referring to the postformal operations she proposed (see Sinnott, 1984, 1998; Sinnott et al., 2017). The PFTQ has been used widely (Benovenli et al., 2011; Galupo et al., 2010; Griffin et al., 2009; Jennings et al., 2009; Jory et al., 2018; McLaughlin

et al., 2018; Pearson et al., 2018; Sinnott et al., 2016, 2017, 2020; Sinnott & Johnson, 1997; see also relatedly Collins et al., 1997; Vukman, 2005), and its psychometric properties have been studied (Cartwright et al., 2009) defining a modest internal consistency (Cronbach's $\alpha = .63$) and evidence of validity (Cacioppo et al., 1984). The factor structure of the questionnaire has also been studied (Cartwright et al., 2009) and three factors were found to account for 46% of the variance. The first factor, called *Multiple Elements*, refers to the ability to consider multiple elements in a given situation. The second is called *Subjective Choice* and it consists of choosing a particular logical system, while the third factor is that of *Underlying Complexities*, which is related to the ability to perceive the underlying complexities of a specific situation. While each of these factors are thought to represent "an important component of complex postformal thinking" (Cartwright et al., 2009, p. 188), this factorial solution might not be so evident from Sinnott's own theoretical framework. Indeed, to our knowledge, this factor structure has not been replicated in any other study, some of which limited themselves to using that obtained by Cartwright et al. (for instance, see McLaughlin et al., 2018). Similarly, as far as we know the PFTQ has not been adapted and validated to other cultural contexts or languages.

Overview of the study

In this context, the aim of this study was to adapt the PFTQ and validate it for use in the Spanish population, obtaining evidence of validity based on the empirically tested relationship of PFT with other relevant personality and cognitive variables. The interest in measuring PFT from the full and practical perspective of Sinnott's relativistic operations (e.g., Sinnott, 1989a) justifies the decision to validate the PFTQ over other relevant measures, such as the Social Paradigm Belief Inventory (SPBI) that from the outset focused on the social domain (Kramer et al., 1992). In truth, both instruments address relativistic and dialectical thinking, albeit not through identical postformal frameworks, and they correlate strongly with measures extracted by interview (Kramer et al., 1992; Sinnott et al., 2017). However, the PFTQ is shorter than the SPBI, even though the SPBI has become structurally (Kramer & Kahlbaugh, 1994) or functionally (Yang et al., 2010) shortened. Furthermore, strong internal consistency can be obtained for the PFTQ (Jory et al., 2018), comparable to that obtained for the relativistic and dialectical statements of the SPBI. In addition, the developmental pattern of the SPBI has opposing tendencies between relativistic and dialectical thinking (Kramer et al., 1992), making it difficult to employ a global score and leading to only moderate ($\alpha = .70$: Mehrad Sadr et al., 2018) or very low ($\alpha = .47$: Vanier & Searight, 2013) internal consistency when calculated. The PFTQ can provide a global measure, with scores ranging from 10 to 70 and using three sub-scales, although this structure does require further study (Cartwright et al., 2009). Likewise, the need to study developmental patterns of PFT in adults of different ages has been indicated by many who routinely use the PFTQ (see Benovenli et al., 2011; Galupo et al., 2010; Griffin et al., 2009; Lomranz & Benyamini, 2016; Sinnott et al.,

2016, 2017, 2020). This could be achieved by analyzing the psychometric properties and factor structure of the PFTQ in distinct adult age groups (Cartwright et al., 2009). Moreover, the very nature of relativistic operations could reflect a significant relationship between the PFTQ and unified dimensions of human activity, e.g., personality (see Griffin et al., 2009; Sinnott et al., 2020).

The relationship between PFT and cognitive and personality variables

As already mentioned, to validate the Spanish version of the PFTQ it is necessary to provide evidence from previous studies that links PFT and both cognitive and personality variables. Thus, awareness of thinking patterns (i.e.: metacognition) is a specific requirement of the PFTQ (Sinnott et al., 2017). Indeed, a strong and significant correlation between relativistic-dialectical thinking and adequate reflection on the thinking process was found (Vukman, 2005). In addition, both processes increase in parallel, suggesting that metacognition could be a major factor underlying PFT (Vukman, 2005). Further empirical evidence linked metacognition to PFT (see Pearson et al., 2018; Wynn et al., 2016) and therefore, in our validation we employed a specific metacognition scale as well as a learning strategies scale for university students.

Other personality measures were also employed as a significant link exists between PFT and personality (Friedman, 2004), such as with the Openness to Experience and Conscientiousness personality traits (Griffin et al., 2009). Indeed, a similar relationship between PFT and both these personality traits was alluded to previously, yet not in exactly the same terms (Commons et al., 2011). In particular, a conscientiousness measure was adopted in this study, which is particularly relevant as this trait could be useful to enable the diverse perspectives and perceptions in a situation to be *orchestrated* (Griffin et al., 2009).

Mindfulness was also considered, a process that involves attending to experiences that appear in the conscious moment *without* censoring them based on their particular logic (Sinnott et al., 2020). Furthermore, mindfulness would promote PFT at the cognitive level (Sinnott, 2010), while such complex thinking also seems to be necessary for meditative practice to operate in two contradictory realities, i.e.: spiritual and real life (Sinnott, 1998, 2001). Consistent with these arguments, a significant relationship between PFT and mindfulness was detected (Sinnott et al., 2020; see also Zerubavel & Messman-Moore, 2015).

A measure of academic resilience was also contemplated. In a work conflict context, training active listening, reframing, and brainstorming would lead to PFT by affecting different post-formal operations (Weitzman & Weitzman, 2006). Similarly, PFT is related to coping flexibility and thus, higher levels of dialectical thinking are linked to a more balanced coping profile and a better fit of strategy-situation (Cheng, 2009). To the extent that resilience is related to problem-solving and coping flexibility (for instance, see Galatzer-Levy et al., 2012; Yu Wu et al., 2020), PFT would also be linked to resilience (see Deng et al., 2020; Jenkins, 2005; Zheng et al., 2020).

Furthermore, a measure of grit (perseverance, as well as passion for long-term goals) was used. On the one hand, dialectical thinking is positively related to creativity consistently (Paletz et al., 2018; see also Chua et al., 2021). On the other hand, grit has been proposed by some to be a good construct to measure creativity (Rojas & Tyler, 2018), for which others have offered empirical support (see Suen-darti et al., 2020; Yushen Wu et al., 2021). Thus, both PFT and grit are closely linked to creativity and thus, a relationship between PFT and grit would be expected when also taking into account that PFT and grit highlight the element of perseverance. Moreover, and with respect to grit, the relationship of creativity with perseverance is somewhat stronger than that it holds with passion (Abuhassan & Bates, 2015; Grohman et al., 2017, study 3; Kunat, 2018; see also Karwowski & Wiśniewska, 2021; Rojas & Tyler, 2018). Importantly, persistence was explicitly linked to PFT when explaining the personality traits characteristic of innovative scientists who must take steps toward higher stages of postformal concept synthesis (Commons et al., 2011). Moreover, the relationship between PFT and grit is expected, insofar as grit is empirically linked to conscientiousness (see Grohman et al., 2017), and as noted above, there is also a link between PFT and conscientiousness.

PFT has also been associated with wisdom (see Kallio, 2011, 2020; Ruisel, 2005; Sinnott, 1998), mostly from a cognitive-developmental perspective or from wisdom's synthetic mode (Kramer, 2000; McLaughlin et al., 2018; Moraitou & Efklides, 2012; Takahashi & Overton, 2002; Zambianchi, 2020). However, a significant empirical relationship between wisdom and PFT is not always found (Staudinger, 1999). Thus, despite the relationship between PFT and tolerance to uncertainty (Bronowski, 1974, as cited in Sinnott, 2010; Cheng, 2009; Dyga & Opoczyńska-Morasiewicz, 2020; P.-L. Wu & Chiou, 2008), awareness and management of uncertainty might be a particularly critical aspect of wisdom such that it constitutes an explicit criterion in wisdom models (Baltes et al., 1992; Mickler & Staudinger, 2008; Moraitou & Efklides, 2012; Smith & Baltes, 1990; Staudinger, 1999). Consequently, a measure of intolerance to uncertainty was used in our study to check whether, even if there is a negative relationship with PFT, it is of low magnitude, given the particular relationship of better managing uncertainty through wisdom as opposed to PFT.

In summary, an analysis of the internal consistency and factorial structure of the PFTQ adapted to the Spanish language was carried out through a cross-validation study. Furthermore, invariance in gender and age groups was studied according to the factor model selected in the prior cross validation, and a comparison of latent means among age groups was performed. In addition, evidence of validity

was obtained regarding a series of the variables mentioned above. Specifically, significant and positive correlations were expected between the PFTQ and mindfulness, metacognition, resilience, grit and conscientiousness. We also expected to find stronger correlations between PFTQ and the components of these measures that most specifically address: a) awareness of cognitive activity in relation to metacognition; or b) perseverance and/or problem solving in relation to grit, conscientiousness and resilience. Conversely, we expected to find a negative and significant correlation, but of a lower magnitude, between PFTQ and intolerance to uncertainty, given that it is a variable more directly related to wisdom. Finally, given the truly developmental nature of PFT, further evidence of validity could be obtained by studying patterns associated with aging. Although our study is not longitudinal, to some extent we were able to examine the developmental progression of PFT through a cross-sectional approach.

Methods

Participants and Procedure

The study was carried out on a sample of 1093 adults (292 males, 801 females), recruited from students enrolled on Psychology courses at the National University of Distance Education (UNED, Spain) who volunteered to participate in this study. Their age ranged from 18 to 71 years ($M = 35.66$, $SD = 11.37$) and the participants were divided into three age groups according to published criteria (Arnett, 2000; Lachman et al., 2015; Mehta et al., 2020): emerging adulthood ($N = 401$; age range 18-29, $M = 23.78$, $SD = 3.14$; 75 males, 326 females); established adulthood ($N = 437$; age range 30-45, $M = 37.36$; $SD = 4.63$; 120 males, 317 females); middle adulthood ($N = 240$; age range 46-60, $M = 50.69$, $SD = 3.75$; 86 males, 154 females).¹

Additional sociodemographic data were collected from the subjects, including their marital status: 53.1% of the sample was married or with a stable partner; 40.3% were single; 6% separated or divorced; and 0.6% widowed. Moreover, 68.1% reported having children and 31.9% did not. With respect to nationality, while 96.1% of the participants were holders of Spanish nationality, 2.1% were of other European nationalities (France, Italy, Portugal, United Kingdom, Romania and Russia), and 1.3% were nationals of Central and South American countries (Argentina, Brazil, Colombia, Mexico, Paraguay, Peru or the Dominican Republic). Finally, 1 participant was Moroccan and 0.5% were from other countries not identified in the survey. With respect to the current pursuit of studies in Psychology, 34.3% of the sample accessed from university studies, 44.5% did so with a pre-university level of studies and the remaining 21.2% accessed their current Psychology studies through other unspecified routes. Regarding employment status,

¹ Given the small number of participants over 60 years of age ($N = 15$), an old adulthood group was not established. As a result, these subjects were excluded from the analyses of specific age groups (i.e.: the measurement of invariance relative to age, as well as the comparison of the latent means in the PFTQ, and of the correlations between the PFTQ and cognitive and personality variables in each age group), although they were included in the rest of the analyses carried out in the study.

45.8% of the sample was currently working as opposed to 41.4% who were unemployed. By contrast, 2% were retired and the remaining 10.7% reported various other situations.

Students were contacted according to a recruitment protocol that involved disseminating the invitation to participate in the study through messages and the forums associated with the Psychology courses themselves. The data was gathered using a secure online survey assessment tool, collected through the Qualtrics website (<http://www.qualtrics.com>) where the participants were asked to respond to all items of the survey. After providing a general explanation of the nature and aims of the research, and prior to their enrolment, each participant was asked to provide their informed consent to participate in the study. In no case was any information used that could identify the student outside the context of the study. Participation in the study was subsidized by granting 1 free configuration credit, equivalent to 25 hours dedication to the degree course.

Some measures were adopted to ensure the proper application of the tests. It was considered that as participation was not anonymous but rather, the subjects had to identify themselves in order to be given a credit, this would to some extent ensure stronger commitment to the survey. In addition, before beginning the survey, subjects read a series of instructions that included the following: "There are no right or wrong answers, we just want to know your opinion or the degree to which the answers best fit your situation. Please complete the survey without rushing and avoid any additional sources of distraction. Your active involvement is necessary for the data collected to be useful and valid. Please try to answer as sincerely as possible". Likewise, in light of the number of questionnaires used, to avoid fatigue it was decided to obtain the responses in two sessions, leaving at least 24 hours between the first and second session.

This study was approved by the ethics committee at the UNED.

Instruments

The Complex Postformal Thought Questionnaire (PFTQ). Participants were asked to indicate the likelihood of thinking or acting in accordance with the 10 postformal operations established by Sinnott (see [Table 4](#)) on a Likert scale from 7 (very true of myself) to 1 (not true of myself), such that the total scores obtained ranged from 10 to 70. Each of the items was carefully translated into Spanish by expert translators and the translations were discussed by a group that included experts in PFT, psychometrics and the translators themselves to reach a consensus. These new translations were back-translation into English to ensure the correct comprehension of the items in Spanish and to guarantee fidelity to the original content, in accordance with published guidelines for test adaptations (Muñiz et al., 2013).

The Mindfulness subscale of the *Self-Compassion Scale - Short Form* (SCS-SF: Raes et al., 2011). This subscale is composed of 2 items ("When something painful happens I try to take a balanced view of the situation", "When something upsets me I try to keep my emotions in balance") and

the participants were asked to indicate how they perceived their responses to such situations on a 5-point Likert scale from 1 (almost never) to 5 (almost always). The Spanish scale (validated by Garcia-Campayo et al., 2014) was used in this study and while the mindfulness subscale has a Cronbach's alpha = .64, the Spanish validation gave a Cronbach's alpha = .74 for this subscale and a Cronbach's alpha = .80 was achieved in this study. Although it was recommended that the full scale should be used (SCS, 26 items: Neff, 2003; Raes et al., 2011), when the user's interest resides specifically in a subscale, the high level of reliability obtained in our study for the mindfulness subscale warrants the use of the short form.

The Metacognitive Self-Regulation Scale (MSR) is one of the fifteen scales of the Motivated Strategies for Learning Questionnaire (MSLQ: Pintrich et al., 1991). Specifically, it belongs to the learning strategies section of the MSLQ and it is the only one that focuses on metacognitive strategies. This scale contemplates the metacognitive self-regulatory activities of planning, monitoring, and regulation. Thus, the scale focuses on the ability to monitor one's own mental processes and adjust them if necessary. It is composed of 12 items (e.g., "When I get confused about something I am reading for this class, I go back and try to understand it"), which are assessed on a 7-point Likert scale from 1 (not at all true for me) to 7 (very true for me). The MSLQ was translated and adapted to Spanish (Roces et al., 1995) and a factor analysis led to a reduction of the MSR scale from 12 to 8 items. Thus, here only these 8 items were considered to obtain the score for the scale. The Cronbach's alpha values obtained by the authors of the scale, as well as in the Spanish validation and the current study were .79, .68 and .79, respectively.

The Brief-ACRA Scale on learning strategies for university students (de la Fuente & Justicia, 2003). This scale is composed of 44 items grouped into 3 factors: cognitive and learning control strategies; learning support strategies; and study habits. Participants are asked to indicate the frequency with which they act in relation to statements that refer to the behavior under study using a 4-point Likert-type scale that ranges from 1 (never or almost never) to 4 (always or almost always). Through a cross-validation strategy, a 17-item version was obtained (Jiménez-García et al., 2018) with better goodness-of-fit indicators than those of the original scale and with adequate evidence of validity. This new, shorter version includes 3 factors and it was the version used here. The first factor is called micro-strategies and it is composed of 5 items (e.g., "I elaborate summaries after underlining"). The memorizing-keys and metacognition factor attempts to capture the ability to self-regulate the learning process together with cognitive cues for memorization, and it is composed of 5 items (e.g., "I recognize the role of learning strategies for memorizing"). Finally, the social-emotional support factor is composed of 7 items that emphasize the social nature of the learning process, addressing aspects like problem solving with family or peers, or prosocial academic behavior (e.g., "I turn to classmates, teachers or family to clarify study doubts"). These last three 3 scales showed adequate internal consistency (Cronbach's

alpha = .78, .86, .78, respectively) and in this study, the Cronbach's alpha of these scales was .87, .76 and .66, respectively.

The Short Grit Scale (Grit-S: Duckworth & Quinn, 2009) is an 8-item version of the original 12 item self-reporting measure of grit (Grit-O: Duckworth et al., 2007), each of which are rated on a 5-point scale from 1 (not at all like me) to 5 (very much like me). Grit-S is psychometrically stronger than Grit-O, which together with the fact that it is shorter, makes its use more recommendable (Duckworth & Quinn, 2009). Grit-S consists of two subscales, Consistency of Interest (e.g., "I often set a goal but later choose to pursue a different one") and Perseverance of Effort (e.g., "I finish whatever I begin"). In addition to a two-factor structure, a second-order latent factor was obtained such that a total score can be obtained (Duckworth & Quinn, 2009). Along these lines, the validation of the Spanish version of Grit-O showed a poor fit of the two-factor structure (Barriopedro et al., 2018) and in line with this, more satisfactory psychometric results were obtained with Grit-S (Barriopedro et al., 2018; Fernández-Martín et al., 2018), obtaining two first-order factors and one second-order factor. The Cronbach alpha values for the entire scale ranged from .73 to .83, they were from .73 to .79 for the Consistency of Interest subscale and from .60 to .78 for the Perseverance of Effort subscale. For the validated Spanish scale, the Cronbach's alpha values were not high: for the total score, .66 and .71; for the Consistency subscale, .68 and .67, and .54 and .60 for the Perseverance subscale (Barriopedro et al., 2018; Fernández-Martín et al., 2018, respectively). By contrast, the reliability coefficients we obtained were notably higher, with Cronbach alpha values for the total score, Consistency subscale and Perseverance subscale of .80, .80 and .67, respectively. In addition, and as already noted, Grit-S fits the data better than Grit-O, not only in the validation of the Spanish version (Barriopedro et al., 2018) but also with the original version (Duckworth & Quinn, 2009), supporting our decision to use the Grit-S. This is especially important given that the theoretical link between PFT and grit points to the relevance of testing the expected relationship of PFT with the two grit factors.

Academic Resilience Scale (ARS-30: Cassidy, 2016). This scale consists of 30 items that are assessed using a 5-point Likert-type scale from likely (1) to unlikely (5). Participants are asked to imagine themselves in an adverse academic situation where they do not pass an exam, receiving comments from their tutor that indicate a lack of understanding, poor writing and expression, as well as suggestions for improvement. The items are grouped into three dimensions: perseverance (14 items, e.g., "I would work harder"), which includes aspects such as not giving up, resolving problems in an imaginative way or conceiving adversity as an opportunity to improve; reflecting and adaptive help-seeking (9 items, e.g., "I would try to think more about my strengths and weaknesses to help me work better"), which includes aspects such as seeking help, support and encouragement, monitoring effort and achievements, and administering rewards and punishments; finally, negative affect and emotional response (7 items, e.g., "I would feel like

everything was ruined and was going wrong"), which includes elements such as anxiety, catastrophizing or avoidance of negative emotional responses. This scale was attributed an adequate internal consistency: Cronbach's alpha = .83 for the perseverance subscale; .78 for the reflecting subscale; .80, for the negative affect subscale. Furthermore, although it is recommended to use the scale in a multidimensional way, the robust correlations between the factors obtained make it possible to obtain a total score with a high internal consistency (Cronbach's alpha = .90). As a Spanish version of this scale has yet to be validated, we did so, and confirmatory factor analysis (CFA) achieved an acceptable fit for the three factor model of the Spanish version (root mean square error of approximation index [RMSEA] = .075, comparative fit index [CFI] = .964, non-standardized fit index [NNFI] = .961, standardized root mean square root [SRMR] = .077). Accordingly, internal consistency indices were calculated for the total scale, the perseverance subscale, the reflecting subscale and for the negative affect subscale, all producing good values (Cronbach's alpha = .92, .86, .78 and .86, respectively).

Intolerance of Uncertainty Scale (IUS-12: Carleton et al., 2007). This measure is intended to assess the reactions to uncertainty, ambiguous situations and the future. This abbreviated scale was used because it has adequate psychometric properties, similar to the original scale (Freeston et al., 1994). Although the short version has not been translated into Spanish, there is a Spanish validation study of the full version (González-Rodríguez et al., 2006). Therefore, given that the items in the short version are identical to those of the full version, the 12 items of the short version were selected and assessed on a 5-point Likert-type scale from 1 (not at all characteristic of me) to 5 (entirely characteristic of me). There are two factors that represent both prospective anxiety (e.g., "Unforeseen events upset me greatly") and inhibitory anxiety (e.g., "Uncertainty keeps me from living a full life"). The reduced version has an overall high internal consistency (Cronbach's alpha = .91), as do each of the two factors (Cronbach's alpha = .83 for inhibitory anxiety; .93 for prospective anxiety). In our study we only used the total score, as recommended previously (Buhr & Dugas, 2002; Norton, 2005), with a Cronbach's alpha = .92.

The Conscientiousness scale of the *Big Five Questionnaire* (BFQ: Caprara et al., 1993). The BFQ was developed to assess the "Big Five" factors of personality and it represents one of the most widely used instrument to assess personality. It is comprised of 132 items that are assessed using a Likert-type scale with 5 options, ranging from complete disagreement (1 = very false for me) to complete agreement (5 = very true for me), and they provide information regarding five dimensions: energy, friendliness, conscientiousness, emotional stability, and openness. Each of these dimensions can be divided into two sub-dimensions. In this study only the BFQ scale specific to conscientiousness was used, with its two sub-dimensions, which are scrupulousness (e.g., "I usually attend to the smallest details of everything") and perseverance (e.g., "I always pursue the decisions I've made through to the end"). The Spanish

adaptation of the BFQ (Bermúdez, 1995) was used in this study. The internal consistency of conscientiousness of the original version is .81 and .78 in both sub-dimensions, the Spanish validation gave a Cronbach's alpha = .79 for conscientiousness; .71 for scrupulousness and .76 for perseverance. In this study, the internal consistency values were .87 for the total scale, .83 for the scrupulousness sub-dimension and .87 for the perseverance sub-dimension.

Data Analysis

There were no missing values in the data collected because the questionnaires were administered online and the participants had to answer all items. The data analysis was performed sequentially, firstly performing a cross-validation study. For this purpose, two random sub-samples were generated with SPSS 25, assigning approximately 50% of the participants to each sample. The first sub-sample ($N = 541$) was used to carry out the exploratory factor analysis (EFA), with an age range from 18 to 68 years ($M = 35.29$, $SD = 11.25$: 148 males, 393 females). Before performing the EFA, the Normed Measure of Sampling Adequacy (Normed-MSA) index of each item was calculated to detect and rule out possibly problematic items (as recommended by Lorenzo-Seva & Ferrando, 2021). The normed-MSA index of all the items ranged from .85 to .93, all values above .50, which indicates that the correlation matrix is well suited to a factorial analysis and that it was not necessary to discard any item. Because the items in the PFTQ are assessed with a 7-point Likert-type scale, and due to the lack of multivariate normality in the data (multivariate Mardias' test of skewness and kurtosis = 509.543: $p < .001$), an estimation method appropriate to ordinal data was used to carry out the EFA. Accordingly, a robust diagonally weighted least square estimation method (Robust DWLS) was employed using polychoric correlations. The number of factors to be extracted was determined by an optimal (Timmerman & Lorenzo-Seva, 2011) and classical implementation of a parallel analysis (PA: Horn, 1965), and with the Hull method based on a robust CFI and a robust RMSEA goodness-of-fit indices (Timmerman & Lorenzo-Seva, 2011). Likewise, an assessment of essential unidimensionality was carried out by computing the following indices: Unidimensional Congruence (UniCo), Explained Common Variance (ECV), and mean of item residual absolute loadings (MIREAL). The UNICO $> .95$, ECV $> .85$ and MIREAL $< .30$ values suggest the data can essentially be treated as unidimensional (Calderón-Garrido et al., 2019; Ferrando & Lorenzo-Seva, 2018). The software used was Factor 10.5 (Lorenzo-Seva & Ferrando, 2006).

The second sub-sample ($N = 552$), with an age range from 18 to 71 years ($M = 36.02$, $SD = 11.48$: 144 males, 408 females), was used to evaluate the fit of competing models to the internal structure of the test by means of a CFA: the one-factor and the three-factor models proposed (Cartwright et al., 2009). In the three-factor model, the factors are referred to as Underlying Complexities, Subjective Choice and Multiple Element (see Introduction), and they contain 3, 3 and 4 items, respectively (see Table 4). As in the first sub-sample, and given that the items are ordi-

nal Likert-type scores and that the assumption of multivariate normality was not met (multivariate Mardias' test of skewness and kurtosis = 731.001: $p < .001$), the diagonally weighted least squares estimation method (Robust DWLS) was employed, together with the polychoric correlation matrix. These analyses were carried out with LISREL (version 8.71, Jöreskog & Sörbom, 1999). We used the Satorra-Bentler Chi-squared test and obtained the following goodness-of-fit indices for the two fitted models: (a) the RMSEA, (b) the CFI, (c) the NNFI, (d) the SRMR, (e) the McDonald's non-centrality index (NCI: McDonald, 1989), and (f) the parsimony-normalized fit index (PNFI). RMSEA values of .08 represent a good fit (according to Hu & Bentler, 1999) and values below .05 represent a very good fit to the data. For the SRMR, values below .08 represent a reasonable fit and values below .05 indicate a good fit. For the CFI and NNFI, values above .90 indicate that the models fit the data well, and values above .95 represent a very good fit to the data. For the McDonald's NCI, values equal to or greater than .90 indicate a good fit and finally, higher PNFI values indicate a more parsimonious model (Hair et al., 2010; Mujaik et al., 1989).

Once the cross-validation study had been completed, the same analyses were all performed on the total sample. Given that the same factorial solution had been obtained in the first sub-sample with EFA and in the second sub-sample with CFA, we proceeded to analyze the total sample with the CFA of the previously selected factorial solution (following the recommendations of Calderon et al., 2022) to take advantage of all the information available in the data. Furthermore, a measurement invariance study by gender and across the age groups (emerging, established and middle adulthood) was carried out, using multi-group confirmatory factor analysis (MG-CFA) with the factor model selected previously (Jöreskog, 2005; Millsap & Yun-Tein, 2004). As a necessary preliminary step in the MG-CFA, the factor model was fitted to each gender and age group separately. Measurement invariance was then assessed by gender and across the three age groups using nested models. To test for measurement invariance across groups, the relative fits of four increasingly restrictive invariance models were compared: the configural, the metric, the scalar, and the strict invariance models. The configural invariance model allows the unstandardized factor loading to vary across age group (the baseline model), while the metric invariance model, which was nested within the configural model, places equality constraints (i.e.: invariance) on those loadings in the three age groups (weak invariance). The scalar invariance model, which was nested within the previous model, is tested by constraining the factor loadings and item intercepts to be the same across groups (strong invariance). Finally, the strict invariance model, which was nested within the scalar model, is assessed by constraining the variance of error of the items (i.e., indicator residuals) to be equal across the groups, in addition to the factor loadings and the item intercepts. In summary, the models are compared progressively, two by two, from the least restricted (configural model) to the most constrained model (strict model). For the comparison between each of the

two nested invariance models, changes in the RMSEA, CFI, NNFI and NCI indices were examined as suggested previously (Chen, 2007; Cheung & Rensvold, 2002). Thus, the most restricted invariance model was selected if the following criteria were met: (a) the difference in RMSEA (Δ RMSEA) between the nested models was $< .01$; (b) those in CFI (Δ CFI) and NNFI (Δ NNFI) were $\geq -.01$; and (c) the differences in NCI (Δ NCI) were $\geq -.02$.

The internal consistency was studied through Cronbach's alpha and the McDonald's omega coefficients, calculated with the MBESS package in R (Kelley & Lai, 2012; Kelley & Pornprasertmanit, 2016), providing 95% bootstrap percentile confidence intervals (CI). Furthermore, corrected item-total correlations were calculated in SPSS 25 to detect items that should be removed due to a weak discrimination index (i.e.: values below .30). Likewise, the descriptive statistics of the items, such as mean, standard deviation, skewness and kurtosis were calculated.

Given that the PFTQ showed reasonable evidence of measurement invariance across age groups, and given the developmental purpose of this study, we compared the latent mean differences across these groups with the latest fitted model in the invariance study. It is known that the latent means of the factors cannot be compared directly, so it is necessary to set the latent mean of a reference group to 0 and then compare the differences in latent means of the rest of the groups to this. Because we are performing multiple comparisons at the same time, a Bonferroni correction was applied to control for the probability of making a type 1 error at $\alpha = .05$, resulting in an alpha value of .0167. Moreover, Cohen's effect sizes (d) and their 95% CI were calculated to evaluate the differences between the latent means.

Lastly, Pearson's correlations between the PFTQ scores and other scales were calculated to assess the evidence of validity in relation to other relevant constructs measured in the study (see above). These correlation coefficients were calculated with the overall sample and also within each age group (i.e.: emerging adulthood, established adulthood and middle adulthood).

Results

Evidence of validity based on the internal structure: the dimensionality of the PFTQ

In the cross-validation study and in relation to the EFA of the first sub-sample, the Bartlett's statistic was significant at 1786.4 (45, $p < .001$) and the result of the Kaiser-Meyer-Olkin (KMO) test was good (.88). Therefore, the inter-item correlation within the data was suitable to perform the EFA. The optimal and classical implementation of a PA suggested only one factor should be extracted, which accounted for 44.1% of the variance. The Hull method, based on a robust CFI and RMSEA, also suggested retaining only one common factor in order to obtain a very good fit (CFI = .974 and RMSEA = .067). The factor loadings of the unidimensional model ranged from .46 to .75, and the UNICO (.96), ECV (.86) and MIREAL (.21) values offered reasonable support to the essential unidimensionality of the PFTQ scores.

Table 1. Goodness-of-fit indices of the one-factor and three-factor models in the second sub-sample

Goodness-of-fit indicators	One-factor model	Three-factor model
S-B χ^2 (df)	112.176 (35)	98.019 (32)
RMSEA [90% CI]	.0633 [.0504, .0766]	.0612 [.0476, .0752]
CFI	.980	.983
NNFI	.974	.976
SRMR	.0502	.0471
PNFI	.755	.693

With respect to the CFA results in the second sub-sample, both the one-factor and the three-factor model achieved a good fit to the data, the three-factor model being slightly better (Table 1). However, the correlations between the three factors in the latter ranged from .88 to .99, which meant that the factors hardly established differentiated conceptual domains and that they basically referred to a unified post-formal reality. In addition, the internal consistency of the three factors in the model was low in terms of the Cronbach's alpha and Omega values obtained (i.e.: Underlying Complexities Factor: $\alpha = .65$, $\Omega = .65$; Subjective Choice Factor: $\alpha = .60$, $\Omega = .60$; Multiple Element Factor: $\alpha = .71$, $\Omega = .71$). The low reliability of these coefficients made it difficult to use the scores of these factors and if we take into account the PNFI, the model to choose would be the unidimensional model that provided the highest value. Therefore, while both models have a good fit the one-factor model is the more parsimonious. This decision is supported by the results obtained with the EFA of sub-sample 1 and therefore, the model selected was the one-factor model. Finally, all estimates of factor loadings in the one-factor model were differed significantly from zero, with values above .50.

Confirmatory Factor Analysis and Measurement Invariance study with the total sample

In the total sample, the CFA of the one-factor model obtained from the preceding cross-validation study gave results consistent with the latter, exhibiting a good fit to the data (RMSEA = .066, 90% CI [.057, .075], CFI = .98, NNFI = .97, SRMR = 0.047, PNFI = .76).

When considering the estimates of the factor loadings in the one-factor model (Figure 1), these estimates differed significantly from zero, with values greater than .50 in all cases except item 4, which gave a value very slightly below .50 (.494). In terms of the invariance study, the CFAs of the one-factor model for each age group and for each gender group were fitted in all cases. Accordingly, the one-factor model obtained a very good fit when applied to all the groups (see Table 2).

The fit of the different nested models was assessed for the invariance study (Table 3). In the case of gender, the four criteria were met and strict invariance was obtained.

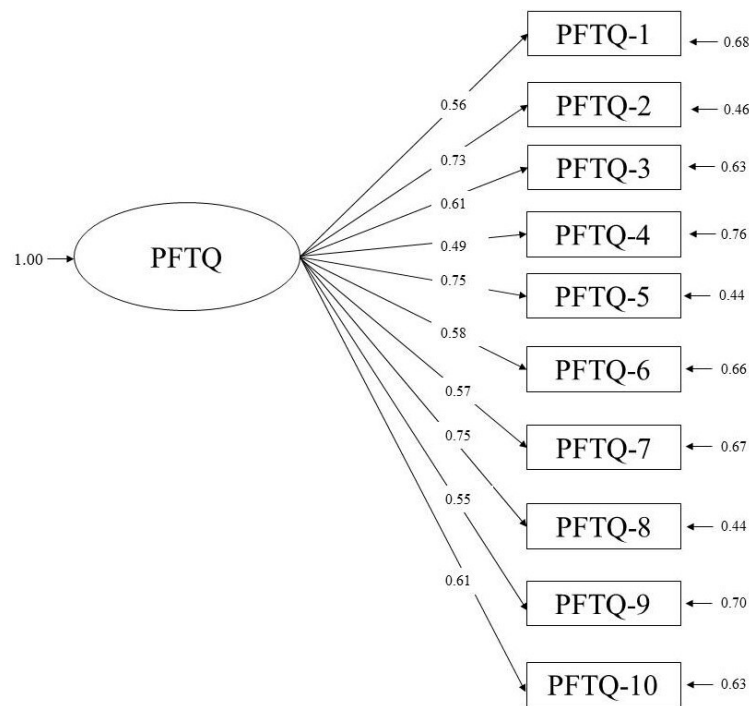


Figure 1. Fully standardized solution of the one-factor model of the PFTQ obtained with the total sample

Table 2. Goodness-of-fit indices of the one-factor model fitted to each gender and to the different age groups

	S-B χ^2 (df)	RMSEA [90% CI]	CFI	NNFI	SRMR	PNFI
Women	178.677 (35)	.0716 [.0614, .0822]	.971	.963	.0522	.750
Men	71.390 (35)	.0598 [.0397, .0796]	.986	.982	.0517	.756
Emerging adults (18-29 years)	101.836 (35)	.0691 [.0537, .0849]	.969	.960	.0573	.742
Established adults (30-45 years)	73.805 (35)	.0504 [.0343, .0665]	.988	.984	.0432	.760
Middle-age adults (46-60 years)	71.561 (35)	.0661 [.0440, .0880]	.981	.976	.0597	.750

However, for the age groups in the scalar invariance model, the RMSEA criterion was met (Δ RMSEA < .01), but CFI, NNFI and McDonald's NCI indices were very slightly higher than the established criteria (Δ CFI = .013, Δ NNFI = .01 and Δ NCI = .034). The analysis of the modification indices indicated that the strongest modification index is that of the intercept of item 4. Leaving this parameter free we obtained partial scalar invariance and the strict invariance model fits properly, meeting the partial scalar and strict invariance criteria.

Internal consistency, psychometric quality and descriptive statistics of the items

The PFTQ scores showed adequate internal consistency, with Cronbach's alpha coefficients of .84 (95% CI [.82, .85]) and a similar McDonald's omega coefficient value of .83 (95% CI [.81, .85]). All items had strong corrected item-total correlations in the range of .42 to .63, such that all the items met the criteria of $r_{pb} \geq .30$ and had an adequate level of item discrimination (Table 4). Likewise, the mean score

of the sample on the PFTQ was 53.28 (SD = 7.86). With regards the skewness and kurtosis indices, two items (items 2 and 10) had values ≥ 1 as an absolute value, indicating the use of a robust estimation together with the polychoric correlation matrix, and in consonance with the approach adopted in this study.

Mean latent comparisons across age groups and evidence of validity based on relationships with other variables

An analysis of the developmental pattern of the PFTQ constitutes an objective itself and a test of validity. When the differences between the latent means of the PFTQ from the age groups were compared with the last fitted invariance model (strict invariance model with the intercept of item 4), the results showed that the latent mean of the established adulthood group was higher than that of the emerging adulthood group, and statistically significant (Δ M = 0.16; SE = 0.01; $p < .05$), with a moderate effect size ($d = 0.283$; 95% CI [0.147 - 0.419]). Likewise, the latent mean

Table 3. Measurement invariance across the gender and age groups

Model	S-B χ^2	df	RMSEA	Δ RMSEA	CFI	Δ CFI	NNFI	Δ NNFI	NCI	Δ NCI
Measurement invariance for gender										
MG Baseline model	243.199	70	.0673		.982		.977		.924	
Metric invariance	263.330	79	.0654	.0019	.981	-.001	.979	.002	.919	.005
Scalar invariance	321.835	88	.0698	-.0044	.976	-.005	.976	.003	.898	-.021
Strict invariance	330.692	98	.0659	.0039	.976	.000	.978	.002	.899	.001
Measurement invariance across the age groups										
MG Baseline model	244.817	105	.0609		.976		.969		.938	
Metric invariance	277.365	123	.0592	.0017	.973	-.003	.971	.002	.932	.006
Scalar invariance	376.492	141	.0682	-.0090	.960	-.013	.961	-.010	.898	-.034
Partial Scalar (intercept item 4 variant)	345.321	139	.0644	.0038	.965	.005	.966	.005	.910	.012
Strict invariance (intercept item 4 variant)	349.520	159	.0578	.0066	.967	.002	.972	.006	.916	.007

of the middle adulthood group was also significantly higher than the mean of the emerging adulthood group ($\Delta M = 0.21$; $SE = 0.01$; $p < .05$) and with a mild effect size ($d = 0.372$; 95% CI [0.211 - 0.533]), albeit higher than that observed between the emerging and established adulthood groups. In addition, the latent mean of the middle adulthood group was significantly higher than that of the established adulthood group ($\Delta M = 0.05$; $SE = 0.01$; $p < .05$), although there was a very small and negligible effect size ($d = 0.086$; 95% CI [-0.072 - 0.243]). Overall, these results indicate that the PFTQ scores increased during adulthood, undergoing a more severe increase upon reaching established adulthood.

To assess the evidence of validity based on the relationship of the PFTQ with other relevant variables, Pearson correlations between PFTQ and a wide set of variables were assessed (Table 5), both in the overall sample and in each age group separately. All the correlation coefficients had the expected sign and thus, the PFTQ was negatively correlated with both intolerance of uncertainty and negative affect, and emotional response, whereas it was positively correlated with mindfulness, the two measures of metacognition, resilience, grit, and conscientiousness. Importantly, in the overall sample and roughly in parallel with the subsamples of each age group separately, differences were observed in the magnitude of the correlation coefficients between PFTQ and the instrument's sub-scales (when applicable). Thus, among the measures of the ACRA Scale on learning strategies for university students, the sub-scale that most directly assesses metacognition showed the strongest correlation with the PFTQ. Likewise, the perseverance component of resilience, grit and conscientiousness measures was that with the strongest correlation with

PFTQ. The correlations with such sub-scales that were theoretically and empirically more closely linked to PFTQ adopted values close to .30 or even close to .40, as did the mindfulness and metacognitive self-regulation measures ($p < .001$ in all cases). Finally, the reflecting and adaptive help-seeking sub-scale (resilience) also produced a significant correlation, above .30.

Discussion

One of the most widely used assessment tools to study PFT is Sinnott's PFTQ, the psychometric properties of which have been analyzed (Cartwright et al., 2009). To our knowledge, this instrument has not been adapted and validated to other cultural contexts or languages, and its use with limited age ranges has not allowed us to explore its usefulness in describing PFT throughout adulthood with sufficient precision. In this regard, our main objective here was to validate a Spanish version of the PFTQ on a large sample with a wide range of ages.

Reliability, validity and factor structure

The psychometric properties of the Spanish version of the PFTQ are excellent (as seen elsewhere: Jory et al., 2018), surpassing the modest internal consistency originally obtained (Cartwright et al., 2009). Without exception, all 10 items of the questionnaire contribute to its high internal consistency.

In terms of the validity testing, beyond the strictly cognitive measures like those employed previously (Cartwright et al., 2009; Sinnott & Johnson, 1997), we assessed a wide selection of both cognitive and personality variables that have theoretically and empirically been linked to PFT. As

Table 4. Item statement, associated postformal operation, descriptive statistics and corrected item-total correlations of the items¹ in the sample

Item statement	Postformal operation	Mean (SD)	skewness	kurtosis	Corrected item-total correlation
1. I see the paradoxes in life [Veo las paradojas de la vida]	Paradox	5.02 (1.34)	-0.47	0.07	.485
2. I see more than one method that can be used to reach a goal [Veo que se puede utilizar más de un método para alcanzar un objetivo]	Multiple methods	6.03 (1.04)	-1.11	1.24	.595
3. I set limits to problems but I really see those problems as more complicated [Acoto y delimito los problemas, aunque realmente veo que son más complejos]	Parameter setting	4.87 (1.27)	-0.37	0.04	.535
4. There are many "right" ways to define a problem; I must make a final decision on how I see the problem [En la vida, hay muchas formas apropiadas de definir un problema y debo decidirme finalmente por una de ellas]	Problem definition	5.03 (1.31)	-0.44	-0.08	.419
5. Sometimes I solve a problem by finding a concrete answer; sometimes I solve it by finding a correct process to deal with problems "of this type". [A veces resuelvo un problema encontrando una respuesta concreta. Otras veces lo hago encontrando un camino o proceso adecuado para abordar ese tipo de problemas]	Process/ product shift	5.60 (1.13)	-0.71	0.46	.634
6. I solve almost all problems using logic, but this may require different types of "logics" [Resuelvo casi todos los problemas utilizando la lógica, aunque esto podría requerir diferentes modos de razonar]	Metatheory shift	4.98 (1.35)	-0.44	-0.24	.517
7. I tend to look for several causes behind any event [Tiendo a buscar diversas causas detrás de cualquier acontecimiento]	Multiple causality	5.40 (1.32)	-0.67	-0.03	.492
8. I often see that a given problem has several good solutions [A menudo veo que un problema tiene varias soluciones válidas]	Multiple solutions	5.55 (1.15)	-0.60	-0.04	.632
9. I often have several goals in mind, and I try to reach more than one in solving a problem [A menudo tengo diversos objetivos en mente e intento alcanzar más de uno cuando me enfrento a una situación]	Multiple goals	5.03 (1.31)	-0.47	-0.18	.482
10. I can see the hidden logic in others' solutions to problems, even if I stick with my own choice of a solution [Puedo entender las soluciones que otros dan a los problemas. No obstante, yo mismo/a elijo la solución que considero mejor]	Pragmatism	5.78 (1.13)	-1.01	1.19	.522

¹ In Column 1 the English and Spanish versions of each item are shown, while column 2 indicates the post-formal operation underlying each item. According to Cartwright et al. (2009), items 1 to 3 correspond to the Underlying Complexities Factor, items 4 to 6 to the Subjective Choice Factor and items 7 to 10 to the Multiple Element Factor.

Table 5. Pearson correlations between the PFTQ and the other cognitive and personality measures in the total sample, and in each age group separately

Measures	r with PFTQ			
	Total sample	Emerging adulthood group	Established adulthood group	Middle adulthood group
ACRA - Micro-strategies	.09**	.11*	.03	.19**
ACRA - Memorizing-keys and metacognition	.28***	.33***	.23***	.31***
ACRA - Emotional-social support	.24***	.27***	.21***	.26***
Metacognitive Self-Regulation Scale	.32***	.35***	.30***	.25***
Intolerance of Uncertainty Scale	-.13***	-.12*	-.08	-.09
Resilience - Total	.39***	.35***	.36***	.42***
Resilience - Reflecting and adaptive help-seeking	.33***	.30***	.37***	.29***
Resilience - Negative affect and emotional response	-.26***	-.22***	-.21***	-.29***
Resilience - Perseverance	.39***	.37***	.35***	.45***
Grit - Total	.24***	.20***	.16***	.33***
Grit - Consistency of Interest	.12***	.10†	.01	.23***
Grit - Perseverance of Effort	.32***	.28***	.30***	.35***
Conscientiousness - Total	.32***	.35***	.27***	.39***
Conscientiousness - Perseverance	.35***	.34***	.30***	.42***
Conscientiousness - Scrupulousness	.19***	.24***	.15**	.26***
Mindfulness	.35***	.35***	.30***	.34***

Note. † $p < .10$; * $p < .05$; ** $p < .01$; *** $p < .001$

expected, PFTQ is significantly and positively related to metacognition, mindfulness, conscientiousness, resilience and grit, which demonstrates the validity of the questionnaire to assess PFT in adults, as well as confirming the link between PFT and personality (Kallio, 2011). As hypothesized, the correlational coefficient obtained with intolerance to uncertainty is significant yet low, which is not surprising given its more particular link to wisdom (Smith & Baltes, 1990). Thus, the PFTQ is able to discriminate between close but not identical constructs. Similarly, other evidence supports the hypothetical discriminant validity and thus, the metacognition dimension of learning strategies is that most closely related to PFTQ. Regarding grit, conscientiousness and resilience, it is the perseverance component that is most closely related to the PFTQ. Overall, these results highlight the functional nature of PFT. Likewise, the fact that PFTQ correlates with the ability to deploy diverse problem-solving strategies (reflecting and adaptive help-seeking and social-emotional support) both somewhat confirms its relationship with coping flexibility (Cheng, 2009) and highlights the proactive nature of PFT.

Despite the three-factor structure of the PFTQ found in Cartwright et al. (2009), our exploratory and confirmatory factor analyses reveal a unidimensional structure, a result that may not be surprising. A theoretical explanation was offered that is congruent with the three-factor structure obtained previously (Cartwright et al., 2009), although it is possible that this structure is somewhat forced within the framework of Sinnott's theory. Thus, Sinnott's original concept of PFT is barely divisible into discrete factors (i.e.: PFT

has a more *analogue* than *digital* quality; Sinnott, 1998) and the totality of the aspects reflected by the questionnaire's items form an organized whole or *mode* of thinking. Note that each cognitive operation describes a particular aspect of PFT, yet at the same time, they are all related to each other and to problem solving (Sinnott, 1984, 1998, 2010). Sinnott (1984) herself states that "the structure of the relationships within the [relativistic] stage is unique" (p. 319), which does not devalue the importance of performing fine-grained analyses that focus on the idiosyncrasies of a particular aspect of PFT when necessary (for example, see Benovenli et al., 2011). Moreover, the two pillars that form the core of PFT in Sinnott's theory (i.e.: self-reference and ordering formal operations) are closely interrelated and even inseparable. Such self-reference allows the subjective component present in all knowledge to be captured and at the same time, it underlies the logical system finally chosen. Thus, by selecting one logic "there is a kind of necessary subjectivity that must be used" (Sinnott, 1998, p. 27). Two additional elements, of an empirical nature, support the unidimensionality of the scale. When a CFA was performed on the second sub-sample with the three factors identified previously (Cartwright et al., 2009), the analysis corroborated a good fit of this model and for the one-factor model. However, the principle of parsimony led us to choose the unidimensional model as the most appropriate to represent the dimensionality of the questionnaire. Finally, a review of the studies that have used this questionnaire, including those carried out by Sinnott herself, reveals most of them employed a total score (Benovenli et al., 2011; Galupo et al.,

2010; Griffin et al., 2009; Jennings et al., 2009; Jory et al., 2018; Sinnott et al., 2016, 2017, 2020; Wynn et al., 2014, 2016). As such, on a practical level they adopt the unidimensionality of the scale in accordance with Sinnott's consideration that the more postformal operations a subject presents the greater the evidence of having achieved a PFT (Sinnott, 1998, p. 37).

Occasionally, the use of Sinnott's questionnaire has been suggested to validate her own concept of PFT (see Blouin & McKelvie, 2012), which could hide doubts about the theoretical soundness of Sinnott's model (Jory et al., 2018). By contrast, the reliability, validity and factorial structure highlighted by our results strengthen Sinnott's theory.

The developmental pattern and significance of PFT

To date, the developmental course of PFT has not been studied with this questionnaire, particularly on such a large sample and over such a wide age range. In this regard, the Spanish version of the PFTQ proves to be highly sensitive to the developmental course of this type of thinking.

Overall, the developmental progression of the PFT observed is congruent with other classic studies that focused on relativistic and/or dialectical thinking (see Basseches, 1980; Blanchard-Fields, 1986; King et al., 1983, 1989; Kramer et al., 1992; Kramer & Melchior, 1990; Kramer & Woodruff, 1986; Vukman, 2005). However, the small number of older people in our study, leading to the absence of a separate older age group, means we can only make partial comparisons with other studies. Thus, we cannot test for the possible existence of a curvilinear pattern of PFT (Vukman, 2005, see also Webster et al., 2014, in the context of wisdom), reflecting a rise in middle adulthood and a subsequent decline in older adults. Nevertheless, our study finds an earlier emergence of PFT than seen elsewhere (Kramer & Woodruff, 1986). We observed a progressive increase in PFT during adulthood, reflecting a very significant advance with entry into established adulthood (30–45 years) and a moderate rise or consolidation in middle adulthood (46–60 years). Therefore, this result does not support the possibility that there is no change in cognition after adolescence until an advanced age (Kramer & Woodruff, 1986). Along these lines, the developmental pattern observed also goes against a negative relationship between age and components of wisdom closer to PFT, such as dialectical thinking (Moraitou & Efklides, 2012). By contrast, this pattern subscribes to an ascending and significant progression of dialectical thinking throughout adulthood (Kramer et al., 1992). Likewise, our results are in line with other studies carried out on age groups closer to those established here (King et al., 1983, 1989) and they provide stronger evidence of developmental differences between closer age bands than seen elsewhere (Blanchard-Fields, 1986). Hence, the sensitivity of the questionnaire to reflect the notable increase in PFT from the age of 30 onwards is more evident.

It is also useful to compare the developmental pattern of PFT we obtained with that of wisdom itself. Thus, while the latter does not automatically increase with age (Ardelt, 2010; Mickler & Staudinger, 2008; Smith & Baltes, 1990;

Staudinger, 1999) and its more postformal component has been seen to develop in the opposite direction to that expected (Moraitou & Efklides, 2012), measures of wisdom related to PFT in other studies indicate differences in favor of the older age group, reflecting more similar patterns to those seen here (see Ardel, 2009; Takahashi & Overton, 2002).

Importantly, the developmental progression in relativistic operations we found proves more compelling than that revealed by Sinnott's initial studies. Although Sinnott found links between relativistic operations and age (Sinnott, 1989b, 1991), she concluded that in general there was no support for a significant influence of age on postformal operations (Sinnott, 1998, p. 151) but rather, she highlighted the importance of individual differences in the deployment of postformal performance. More in line with our results, age sometimes indirectly influences relativistic operations coded according to Sinnott's criteria to identify relativistic thinking, such as in community residents (Collins et al., 1997), or it does so directly (Vukman, 2005). In the latter case, a developmental progression from adolescence to old-age was identified (63–70 years) by adapting a dialectical problem according to Sinnott ("the grandmother problem").

It is well known that professional and family life constitute the fundamental social obligations characteristic of adulthood. In this sense, the developmental pattern obtained by us would indicate that PFT is at the service of typical developmental tasks that are performed prominently after the age of 30, such as intimacy and generativity above all (Erikson, 1963), or those typical of the responsibility and executive stages (Schaie & Willis, 2000). Not surprisingly, Sinnott's theory is particularly focused on analyzing the cognitive operations at the service of meaning, identity and intention that guide adult life (Ståhle et al., 2020). In particular, if one considers that cognition is a tool of adaptation and that "the years from 30 to 45 are often the most intense and demanding years of adult life in developed countries" (Mehta et al., 2020, p. 432), our results highlight the role of PFT in this age group, recently baptized as "established adulthood" (Mehta et al., 2020). In this regard, work, family, and relationships (as well as creativity) are highly salient concerns and challenges of adulthood in this period of life, when the individual's potential for self-realization is particularly intense and the generative balance is greater than at previous stages of development (Karwowski & Wiśniewska, 2021). For example, in terms of professional development, it was found that 45 years of age is the median age to set-up 1 in 1,000 of the fastest-growing startups (Azoulay et al., 2020). In relation to parenting behavior, which is linked to generativity (see Karacan, 2014), parental identity achievement increases from 36 to 42 years of age, remaining stable to 50 years of age (Fadjukoff et al., 2016). In fact, the most intensive progression in parental identity occurs between the ages of 36 and 42. A recent meta-analysis revealed that generativity at work was only slightly more salient in middle age and it can occur at any point during the individual's working life (Doerwald et al., 2021). Likewise, empirical evidence suggests that genera-

tivity is important in developmental periods prior to mid-life (see Mackinnon et al., 2016) and it seems to be particularly beneficial for personal growth from early adulthood through to late adulthood (Toyama et al., 2020). It is no coincidence that regarding creativity in adulthood, productivity peaks in the late thirties or early forties (Karwowski & Wiśniewska, 2021). Furthermore, and in the specific context of Spain, young Spaniards wait beyond the age of thirty to become independent, have children and stabilize their position in a precarious labor market (Moreno et al., 2012). Not surprisingly, Spain is one of the countries with the latest youth emancipation in Europe, with 64.5% of young people between 18 and 34 living in their homes of origin (INJUVE, 2021). These data are also entirely congruent with the fact that the transition to adulthood is now a longer period than ever before (Knežević, 2018), as particularly evident in Spain (Zacarés et al., 2015; see also Fierro & Moreno, 2007).

Relativistic operations would appear to be fundamental to the psychosocial development of the individual in adulthood when most needed. Moreover, our study confirms the existing relationship between PFT and variables of particular importance for adaptive functioning, such as metacognition (Vukman, 2005), perseverance (Griffin et al., 2009) or problem solving/coping flexibility (Cheng, 2009; Weitzman & Weitzman, 2006). More specifically, some empirical evidence supports the role of PFT in addressing the tasks faced by 30 and 40 year olds. In analyzing the styles of problem solving, one style typical of middle-age (41 years of age) was characterized by higher scores of ideational productivity, association, and flexibility in responding to ill-structured problems (Sinnott, 1989b). That is, this is a highly functional style for the generative adult. Similarly, increases in dialectical thinking that began in early adulthood were proposed to be related to adult demands (Kramer et al., 1992). Likewise, in the framework of wisdom, as perceived and experienced in an individual's life, the accounts of 30-40 year-olds focused largely on self-determination and assertion, again adapting this to achieving goals in that developmental period (Glück et al., 2005).

Finally, the fact that the significant increase in PFT levels in middle-age adults (45-60 years) is associated with a small and negligible effect size is consistent with greater stability achieved by this age (Lachman et al., 2015). That is to say, a significantly higher level of PFT may not be required relative to that already acquired when faced with the activities and tasks of day-to-day life but rather, a consolidation or optimal use of the adaptive skills linked to PFT. This is in line with the strong correlations obtained here between the PFTQ, and the cognitive and personality variables in this age group. In addition, while losses occur in this period of life, the passage of age opens further opportunities to reflect, integrate and learn from past experiences (Ardelt, 2009; Staudinger & Pasupathi, 2003). In this possible dynamic between gains and losses, "mid-life is a particularly beneficial position in terms of a balance of strengths and limitations" (Lachman et al., 2015, p. 9), similar to the explanations given in relation to wisdom (Staudinger, 1999).

Limitations, prospective and conclusions

Despite the wide age range of our sample, a limitation of this study lies in the fact that there are few participants over 60 years of age. Furthermore, the sample is incidental, ascribed specifically to a population of psychology students that are individuals with a certain level of education. This might limit the generalizability of the results to the general population. However, despite the established relationship between PFT and educational level (see Benack & Basseches, 1989; Hood & Deopere, 2002), it is unlikely that the developmental pattern found constitutes an epiphenomenon of educational level. Indeed, when educational level (in addition to intelligence) was controlled for, age was seen to explain the variance in relativistic thinking (Hood & Deopere, 2002). Furthermore, if age and education were *naturally confused*, by controlling the latter "an important contextual mediator of developmental progression may be lost" (Blanchard-Fields, 1986, p. 331). Thus, having used a sample of students allows us to elucidate the developmental pattern of a complex skill associated to a particular educational level (Sinnott, 1998).

The assessment instruments used exhibit suitable psychometric qualities and provide undoubted psychological relevance to the study. However, it is also worth considering other non-short instruments as alternatives to the variables assessed. In this sense, despite the recommendation to use Grit-S as opposed to Grit-O (Duckworth & Quinn, 2009), doubts have been cast on the sensitivity of abbreviated measures of grit (Credé et al., 2017). Nevertheless, we generally agree that the use of highly abbreviated personality measures should be reconsidered (Credé et al., 2012).

The present study corroborates the suitability and usefulness of the PFTQ, both due to its excellent psychometric properties and evidence of validity, as well as its ability to capture the developmental course of this complex thinking. This measure is not only important to access the postformal thinking of individuals, and the relationship of this with different scenarios of performance and development but also, to determine the efficacy of interventions in PFT. In fact, given the link already noted between PFT and higher education, designing interventions aimed at promoting PFT could be a very useful curricular element in college education (Basseches, 2005; Pearson et al., 2018; Sinnott, 1998; Wynn et al., 2014, 2016; Zhu et al., 2019), and even more interesting in the context of continuing education and training (Sinnott, 1998).

Future studies should test the developmental course of PFT with this questionnaire in older individuals, in addition to its use in relation to the study of new variables or others in the cognitive, personality and academic domains that have not been sufficiently well analyzed. Such studies may be carried out with a cross-sectional design, although more important benefits are likely to be gained from longitudinal studies.

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Contributions

All authors of the manuscript participated in the different phases and tasks of manuscript preparation, that is, they contributed to the conception and design, data acquisition, data analysis and interpretation, and revision of the article, and they approved the final version submitted for publication.

Competing Interests

The authors declare no competing interests.

Data Accessibility Statement

All materials, including dataset, analysis scripts and PTFQ statements can be found at:

<https://osf.io/vkfex/>

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