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HIERARCHICAL FACTOR STRUCTURE OF THE INTOLERANCE OF UNCERTAINTY SCALE-SHORT FORM (IUS-12) IN THE ITALIAN VERSION

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Despite widespread use, few translations are available for the Intolerance of Uncertainty Scale short form (IUS-12) as well as limited research on its psychometric properties in Italy. Moreover, recent evidence has suggested a multifaceted hierarchical structure for this scale. We compared the two-factor model to second-order and bi-factor models, in which a General IU factor was posited with two more narrow factors: Prospective IU and Inhibitory IU. Models were tested on a pooled dataset of students (N = 609) taking the IUS-12 alone or with other IUS-27 items. The bi-factor model fitted the sample data better than alternative models. The general factor accounted for 80% of the item variance. Presentation mode did not impact scalar invariance. Convergent validity with neuroticism, need for closure, and the uncertainty response scale was high for the total score. As such, scoring the IUS-12 total score is recommended in clinical research and assessment.

Key words: Intolerance of uncertainty; IUS-12; Confirmatory factor analysis; Hierarchical factor structure; Bi-factor model.

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Intolerance of Uncertainty (IU) is "an individual's dispositional incapacity to endure the aversive response triggered by the perceived absence of salient, key, or sufficient information, and sustained by the associated perception of uncertainty" (Carleton, 2016a, p. 31). The IU construct appears to have a core fear of the unknown (Carleton, 2016b). IU has a long history as a personality construct (Freeston, Rhéaume, Letarte, Dugas, & Ladouceur, 1994), with researchers initially focused on relationships with Generalized Anxiety Disorder (GAD; Dugas, Letarte, Rhéaume, Freeston, & Ladouceur, 1995; Dugas, Marchand, & Ladouceur, 2005; Freeston et al., 1994; Ladouceur et al., 1999).

There is now substantial evidence that IU is a broad transdiagnostic construct, comparable across psychopathologies (Boswell, Thompson-Hollands, Farchione, & Barlow, 2013; Carleton, 2016a, 2016b), and accounts for variance in a variety of higher-order constructs (see, for a review, Carleton, 2016a, 2016b; Hong & Cheung, 2015). For example, IU accounts for statistically significant variance in symptoms of panic disorder (Carleton et al., 2014), social anxiety disorder (Boelen & Reijntjes, 2009; Teale Sapach, Carleton, Mulvogue, Weeks, & Heimberg, 2015), obsessive compulsive disorder (Jacoby, Fabricant, Leonard, Riemann, & Abramowitz, 2013; Tolin, Abramowitz, Brigidi, & Foa, 2003), health anxiety (Boelen & Carleton, 2012; Fergus, 2013), separation anxiety (Boelen, Reijntjes, & Carleton, 2014), and depression (Miranda, Fontes, & Marroquin, 2008; Nelson, Shankman, & Proudfit, 2014; Yook, Kim, Suh, & Lee, 2010). IU accounts for variance beyond other important constructs, such as anxiety sensitivity (Boelen & Reijntjes, 2009), fear of anxiety (Buhr & Dugas, 2009), and neuroticism (Boelen & Reijntjes, 2009; Mahoney & McEvoy, 2012b). Patterns of IU responding also appear invariant across anxiety and mood disorders, while being significantly different when comparing clinical and nonclinical samples (Carleton, 2016b).

Carleton, Norton, and Asmundson (2007) proposed IU as a critical dispositional risk factor for clinically significant anxiety and depression, which has been supported by subsequent research (e.g., Carleton, 2016a, 2016b). Boswell and colleagues (2013) conceptualized IU as a "generalized, underlying mechanism" that would be "consistent with the triple vulnerabilities model of emotional disorders" (p. 631). In a subsequent review, Barlow, Sauer-Zavala, Carl, Bullis, and Ellard (2014) echoed prior research, stating that "individuals with emotional disorders, compared with healthy individuals, display greater intolerance for uncertainty, ambiguity, or situations that are perceived as uncontrollable, which leads to heightened negative affect" (p. 349). Neuroscience researchers have also described anxiety "as anticipatory affective, cognitive and behavioral change in response to uncertainty about a potential future threat" (Grupe & Nitschke, 2013, p. 489). Most recently, Carleton (2016a, 2016b) has argued that fear of the unknown and IU represent critical foundational transdiagnostic constructs for anxiety and related psychopathologies.

Reductions in IU have been associated with reductions in symptoms for several disorders (Dugas & Ladouceur, 2000; Dugas & Robichaud, 2007; Grayson, 2010; Hewitt, Egan, & Rees, 2009; Mahoney & McEvoy, 2012a; van der Heiden, Muris, & van der Molen, 2012; Wilhelm & Steketee, 2006). Similarly, the Unified Protocol for the Transdiagnostic Treatment of Emotional Disorders (Barlow et al., 2011) includes an exposure element focused on interactions with IU. The protocol was tested with patients diagnosed with various disorders (i.e., generalized anxiety disorder, obsessive compulsive disorder, panic disorder, social anxiety disorder, or multiple diagnoses) in a 16-week randomized control trial (Farchione et al., 2012). The treatment produced substantial improvements in tolerating uncertainty and those improvements were predictive of reductions in disorder-specific symptoms.

The pervasive importance of IU underscores the need to ensure broad access to robust measurement tools for the construct. The original measure for IU was a 27-item self-report tool (IUS-27; Freeston et al., 1994). Items were derived from 74 statements generated to reflect aspects of IU such as the consequences of being uncertain, how uncertainty reflects on a person, expectations about the predictability of the future, attempts to control the future, frustration around uncertainty, and absolute responses to uncertainty. Items were assessed on face validity by four judges and those deemed irrelevant or redundant were discarded.

Challenges with the IUS-27 factor structure (Buhr & Dugas, 2002; Norton, 2005) and length led to the development of an abridged two-factor 12-item version (IUS-12; Carleton et al., 2007). The two factors were described as Prospective and Inhibitory dimensions of IU (Carleton et al., 2007; McEvoy & Mahoney, 2011). The former reflect desire for predictability and active engagement in information seeking to increase certainty; the latter reflect uncertainty avoidance and paralysis in the face of uncertainty. A parallel two-factor structure was subsequently supported for the IUS-27 (Birrell, Meares, Wilkinson, & Freeston, 2011; Sexton & Dugas, 2009). Researchers have suggested that the IUS-27 items have redundancy (Khawaja & Yu, 2010), as well as items specific to worry that were not included in the IUS-12 (Gentes & Ruscio, 2011). Factor analyses of the IUS-12 have supported a two-factor model rather than a unitary model, despite high (e.g., $r = .75+$) interfactor correlations (Carleton et al., 2007; Helsen, Van den Bussche, Vlaeyen, & Goubert, 2013; Hong & Lee, 2015; Jacoby et al., 2013; McEvoy & Mahoney, 2011). As such, the IUS-12 may have a hierarchical structure. In any case, the demonstrated success of the IUS-12 in detailing the importance of the construct (e.g., Carleton, 2016a, 2016b; Hong & Cheung, 2015) speaks to the quality of the original items and the poignancy of the construct. There have been several alternative measures proposed (e.g., Bottesi, 2012; Comer et al., 2009; Gosselin et al., 2008; Greco & Roger, 2003; Mahoney & McEvoy, 2012b; Thibodeau et al., 2015); however, the IUS-12 appears to be, currently, the most commonly used measure for transdiagnostic research.

IUS-12 studies involving nonclinical or community samples have demonstrated positive correlations with measures of closely related constructs, such as GAD, worry, state anxiety, trait anxiety, and neuroticism (e.g., Boelen & Carleton, 2012; Helsen et al., 2013; Khawaja & Yu, 2010; Rosen & Knäuper, 2009). Similar evidence has been found for relationships with constructs like the Need for Cognitive Closure (NCC; i.e., needing a definitive answer on a topic; Berenbaum, Bredemeier & Thompson, 2008; Kruglanski & Webster, 1996; Rosen & Knäuper, 2009) and there are conceptual relationships with constructs like curiosity and risk aversion (Volz & Gigerenzer, 2012).

Despite the broad importance of IU as a construct and the transdiagnostic popularity of the IUS-12, there are very few translations available and limited research on non-English versions. Regarding Italian studies, an independent research group (Bottesi et al., 2015) has translated a different, but unpublished version of the IUS-12 (see Walker, Birrell, Rogers, Leekam, & Freeston, 2010), of which the current authors were unaware during data collection (see Method section). Briefly, Walker and colleagues' scale differs from the 2007 short form by having rephrased some items and included slightly different items from the IUS-27 to facilitate administration across variant ages and education levels (see Bottesi et al., 2015). As a result of different methodological choices, our translation of the original IUS-12 scale differs from Bottesi et al. in item wording and, to a minor extent, in item composition.

Accordingly, the current study was designed to provide a preliminary contribution to the Italian validation of the IUS-12 (Carleton et al., 2007). The Italian translation of the IUS-12 was expected to produce a comparable psychometrics to the original, including the two-factor structure (see, for a review, Carleton, 2016b; McEvoy & Mahoney, 2011). Bottesi et al. (2015) also supported a two-factor model in the Italian population, retaining the common large factor intercorrelation, and further implicating a hierarchical multifaceted structure in Italian as well as in other languages and countries; nevertheless, no study has evaluated a hierarchical class of models for the IUS-12 scale in Italian and only one study has done so in an English speaking sample (Hale et al., 2016).

In order to model the IUS-12 as a multifaceted construct, we tested two alternative models. First, we examined a second-order factor model, in which a General IU factor was posited to affect item responses through Prospective and Inhibitory IU first-order factors. Second, we tested a bi-factor model, in which a General factor was posited to affect item responses directly and independently from Prospective and Inhibitory group factors (for details see Model Specification, in Method section). Hale et al. (2016) reported an excellent fit for a bi-factor model; however, they did not test a second-order model. From a theoretical point of view, the second-order model assumes that General IU (i.e., "a latent fear of the unknown"; Carleton, 2016a, 2016b) is not directly involved in behavioral manifestations of IU as described by IUS-12 items; instead, the effects are mediated by proximal predictive factors, like Prospective and Inhibitory IU. In contrast, the bi-factor model assumes that the General IU factor is directly associated with behavioral manifestation of IU, above and beyond the effects of "narrower" IU facets, which are posited as independent from the General factor.

METHOD

Participants and Procedure

Data for the current study were derived from three merged datasets to ensure sufficient sample size for robust confirmatory factor analyses (CFA; Bentler & Chou, 1987). Each dataset was originally collected for an independent study, each of which was approved by the ethical committee of the Department of Social and Developmental Psychology, at Sapienza University of Rome. All participants were undergraduate students attending master level psychology classes who volunteered in exchange for partial course credits. Before collecting the data, and after having received written information, participants gave their verbal consent to confirm they had been informed about the aim of the study, anonymity regarding the data gathered, the voluntary nature of participation, and the right to withdraw from the study at any moment. Dataset A included 360 participants (74% women; M_{age} = 23.7, SD = 4.8) who completed the IUS-27 with the Uncertainty Reaction Scale, the Eysenck Personality Questionnaire-Revised, and the Need for Cognitive Closure Scale as part of research on attitudes toward ambiguity (Lauriola, Foschi, Mosca, & Weller, 2016). For the current study, the IUS-12 items were extracted per previous research recommendations (Carleton, Thibodeau, Osborne, & Asmundson, 2012). Dataset B included 167 participants (69% women; M_{age} = 24.4, SD = 2.9 years) who completed the IUS-12 with the Epistemic Curiosity Scale, the Emotion Regulation Questionnaire, the Elaboration on Potential Outcomes scale, and the Risk Taking Measure RT-18 as part of research on epistemic curiosity and self-regulation (Lauriola et al., 2015). Dataset C (n = 82; 89% women; M_{age} = 25.0, SD = 4.3) completed the IUS-12 with the Big Five Inventory as part of ongoing unpublished research. Datasets A, B, and C were pooled in invariance analyses (for details see below) and analyzed separately in concurrent validity analyses.

Measures

Intolerance of Uncertainty Scale short form (IUS-12; Carleton et al., 2007). The IUS-12 was back-translated into Italian for use in the current study. The translation process was based on two back-translation procedures performed separately by independent bilingual professionals.

Then, a third independent translator, without reference to the original text, back-translated the items into English to verify linguistic equivalence. The pre-final version was administered to a small sample of 10 community participants to ensure understandability and clarity of instructions, items, and response format. The items were rated on a 5-point Likert scale ranging from 1 (*not at all characteristic of me*) to 5 (*entirely characteristic of me*). The final item translation is reported in Table 1 (in Results section).

Eysenck Personality Questionnaire-Revised (EPQ-R; Eysenck, Eysenck, & Barrett, 1985; Italian version, San Martini, Mazzotti, & Setaro, 1996). The EPQ-R has 100 items rated on a dichotomous scale (*yes*/*no*). The items assess three major dimensions of personality along three subscales: Extraversion (23 items), Neuroticism (24 items), and Psychoticism (32 items). Moreover, a Lie scale (21 items) measures a social desirability response-set bias. In keeping with EPQ-R validation studies, the internal consistency coefficients assessed in the current study were: .75, .80, .61, and .78 for Extraversion, Neuroticism, Psychoticism, and Lie scale, respectively.

Need for Cognitive Closure Scale (NCCS; Webster & Kruglanski, 1994; Italian version, Pierro et al., 1995). The NCCS assesses motivation with respect to information processing and judgment, desire for avoiding ambiguity, and seeking closure. The 42 items were rated on a 6-point Likert scale ranging from 1 (*not at all characteristic of me*) to 6 (*entirely characteristic of me*). The items assess five major dimensions of closure: Predictability (eight items), Order (10 items), Ambiguity (nine items), Closure (eight items), and Decision (seven items). In this study we used average scores for all the subscales. In keeping with NCCS validation studies, the internal consistency coefficients assessed in the current study were .79, .65, .78, .79 and .78 for Predictability, Order, Ambiguity, Closure, and Decision, respectively.

Uncertainty Response Scale (URS; Greco & Roger, 2001). The URS was back-translated into Italian by the authors (see also Lauriola, Foschi, et al., 2016). The URS is a 48-item scale designed to predict individual differences in coping with uncertainty. The URS is comprised of three factors, Emotional Uncertainty (15 items; uncertainty causes anxiety and sadness), Desire for Change (16 items; desires novelty and change), and Cognitive Uncertainty (17 items; uncertainty causes preferences for order, planning, and structure). We used aggregate scores for the three subscales. In keeping with the URS validation study, the internal consistency coefficients assessed in the current study were .90, .86, and .85 for Emotional Uncertainty, Desire for Change, and Cognitive Uncertainty, respectively.

Epistemic Curiosity Scale (ECS; Litman & Spielberger, 2003; Italian version, Litman, Lauriola, Mussel, & De Santis, 2014). The ECS is a 10-item two-factor scale designed to assess dimensions of curiosity: Interest (I-type; five items; e.g., "I enjoy exploring new ideas") and Deprivation (D-type; five items; e.g., "I can spend hours on a single problem because I just can't rest without knowing the answer"). The items were rated on a 4-point Likert scale (1 = *almost never*; 4 = *almost always*). In the current study, aggregate scores for Interest and Deprivation were used. In keeping with ECS validation studies, the internal consistency coefficients assessed in the current study were .67 and .63 for Interest and Deprivation, respectively.

Risk Taking measure (RT-18; de Haan et al., 2011). The RT-18 was back-translated into Italian by the authors (see also Lauriola et al., 2015). The RT-18 is an 18-item scale measuring two dimensions of risk-taking: Behavior (nine items; e.g., "I sometimes like to do things that are a little frightening") and Assessment (nine items; e.g., "I usually think about all the facts in details before I make a decision," reverse scored). Higher scores on both scales reflected stronger risk taking attitude. Questions can be answered by *yes* and *no*. Reliability coefficients were not assessed for separate factor scores in the validation study (de Haan et al., 2011). In the current study, average scores for Behavior and Assessment subscales were used (αs = .75 and .80, respectively).

Big Five Inventory (BFI; John, Donahue, & Kentle, 1991; Italian version, Fossati, Borroni, Marchione, & Maffei, 2010). It is a self-report inventory designed to measure the Big Five dimensions. The scale is comprised of 44 items (1 = *Strongly disagree*; 5 = *Strongly agree*) measuring five facets of personality: Extraversion (eight items), Agreeableness (nine items), Conscientiousness (nine items), Neuroticism (eight items), Openness to Experience (10 items). In keeping with BFI validation studies, the internal consistency coefficients assessed in the current study were: .86, .74, .85, .84, and .84 for Extraversion, Agreeableness, Conscientiousness, Neuroticism, and Openness to Experience, respectively.

Statistical Analyses

Model Specification

In line with previous research and theory (e.g., Carleton et al., 2007; McEvoy & Mahoney, 2011), we tested the following models: 1) a one-factor model (General IU; Figure 1a), a two-factor model with correlated factors (Prospective IU and Inhibitory IU; Figure 1b), a two-factor model with a second-order factor (Prospective IU and Inhibitory IU loading on a General IU factor; Figure 1c), a bi-factor model with a common factor and two-group factors (Inhibitory IU and Prospective IU and General IU; Figure 1d). Each class of models tested alternative hypotheses about the IU construct.

The one-factor model assumed each item reflected only the variance on a common latent IU factor; whereas each uniqueness term reflected an unspecified mixture of random and systematic variance. Such an assumption is often unrealistic because there are many systematic factors impacting item responses, which can produce poor model fit as a function of increasing item counts. Likewise, the two-factor model expands on the previous model in that the IU domain was divided into separate, but related, subtraits. As such, the two-factor model does not require assumptions regarding a common latent construct directly or indirectly impacting item responses. Instead, item responses on the IUS-12 items are a weighted mean of two relatively independent common factors. Most IUS-12 research supported the two-factor model; however, the second-order factor model appears more theoretically compelling. The model explicitly imposes a hierarchical structure on the data, in which first-order factors are no longer correlated, but they load on a common general factor. As such, item responses reflect the effect of this general factor through specific lower-order facets (i.e., an indirect effect). Like the one-factor model (Figure 1a), the bi-factor model also assumes a single latent factor common to all items; however, it specifies two-group factors that divide random error variance from systematic variance (i.e., common variance to specific groups of items). Unlike the second-order factor model (Figure 1c), the group factors do not mediate the effect of the general factor. In other words, group factors, such as Prospective and Inhibitory IU, do not account for the effect of the General IU trait on item responses (for a thorough review of alternative factor models for a multifaceted construct see Reise, Moore, & Haviland, 2010). Another difference between bi-factor and second-order factor models is the lack of item-factor loadings on the general factor for the latter class of models (see Figure 1, panels c and d). A Schmid-Leiman transformation can be imposed on the factor loading matrix to estimate item-factor loadings on the general factor, recognizing the potential impediments for comparing model parameters. Briefly, lower-order factors were treated as residualized factors after that the variance accounted for by the higher-order factor was partialed out; item variance was first ascribed to the higher-order factor and then to residualized lower-order ones (for details on this procedure see Brown, 2014; Wolff & Preising, 2005).

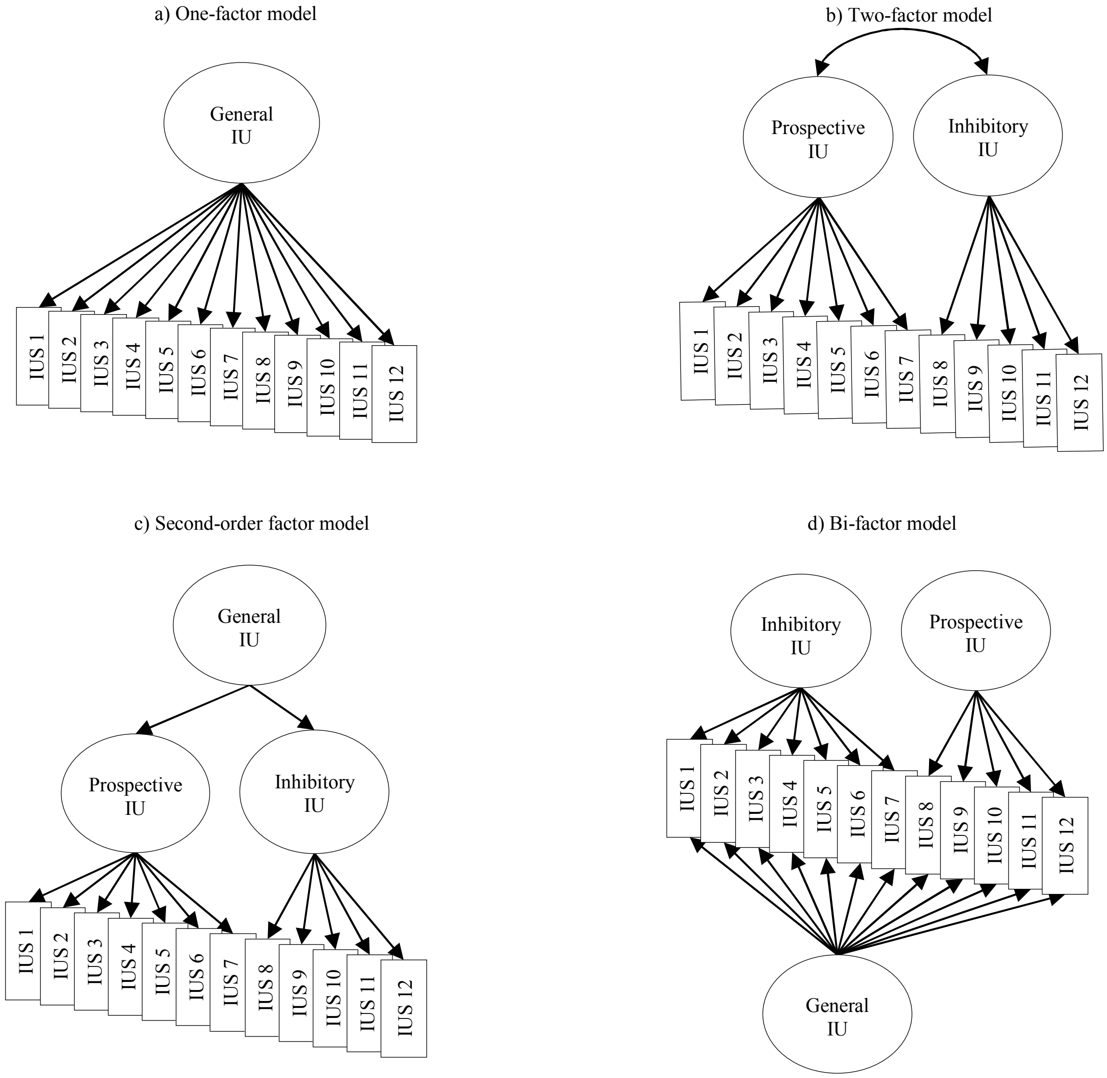

FIGURE 1
Alternative factor models for the Intolerance of Uncertainty Scale (IUS-12).

CFA Model Fit

All datasets were pooled together to test factor models using EQS 6.1 (Bentler, 2004). The data violated multivariate normality assumptions (Mardia's normalized coefficient = 23.64);

accordingly, the robust maximum likelihood (ML) method was used to estimate models. Robust ML provides unbiased parameter estimates, corrects standard errors for non-normal data, and adjusts many of model's fit indices (Satorra & Bentler, 2001). Because of the large sample size, all factor models were expected to have statistically significant chi-square values. The following fit indices and 90% confidence intervals — where applicable — were considered representative of excellent fit and values approaching these cut off scores as indicating an increasingly good fit (Byrne, 2006; Hu & Bentler, 1999; Kline, 2011; Tabachnick & Fidell, 2007): 1) chi-square (values should not be significant); 2) chi-square/*df* ratio (values should be less than 2.0); 3) comparative fit index (CFI; values must be greater than .90, with ideals approaching or greater than .95); 4) Tucker-Lewis index (TLI; assessed per CFI); 5) the standardized root mean square residual (SRMSR; values must be less than .10, with ideals approaching or less than .05); and 6) root mean square error of approximation (RMSEA; values must be less than .08, with ideals approaching or less than .05, with 90% confidence interval values below .10). Goodness of fit evaluations should emphasize the latter four fit indices because of potential chi-square inflation (Hu & Bentler, 1999).

CFA Model Comparisons

All models tested in the present study were nested models (i.e., all parameters of a more restricted model are included in a less restrictive one). For example, the one-factor model (Figure 1a) was nested within the other factor models insisting upon the same set of observed variables (Figure 1, panels b, c, d) by constraining factor paths or correlations either to zero or one. Importantly, the second-order factor model (Figure 1, panel c) was also nested within the bi-factor model (Reise et al., 2010). A scaled chi-square difference test (Satorra & Bentler, 2001) appropriately assessed whether a more restrictive model (i.e., a model with more constrained parameters) produced a better or less restricted fit; however, because of large sample size, trivial differences between models might result in statistically significant chi-square differences. Following recommendations by Cheung and Rensvold (2002), the CFI difference between two nested models (ΔCFI > .010) was taken as evidence of robust differences in relative model fit.

Invariance Analyses

The IUS-12 items from dataset A were derived from the IUS-27; as such, the current study attempted to replicate previous explicit (Carleton et al., 2012) and implicit (e.g., Helsen et al., 2013; Hong & Lee, 2015) evidence that presenting the IUS-12 items alone or with other IUS-27 items produces comparable psychometric results (i.e., dataset A vs. pooled datasets B and C). Following Byrne (2012), the equality of parameter sets for the best fitting model in overall confirmatory analyses was tested across presentation mode groups in a logically ordered and increasingly restrictive way: 1) configuration equality tested whether the same number of factor and factor-loadings are the same across presentation modes; 2) factor-loading equality for the general factor was then imposed; 3) next, factor-loading equality for the general and the specific factors; the model tested metric invariance (i.e., the extent to which respondents taking the IUS-12 across different presentation modes attributed the same meaning to the latent factors); 4) factor-loading equality for the general and the specific factors, observed variable intercept equality; the model tests scalar invariance (i.e., whether people taking IUS-12 items across different presentation modes can be meaningfully compared on their observed scores). Invariance across presentation modes required nonsignificant differences between a more restricted model and a less restricted one, for which we followed criteria described above for nested model comparisons.

Correlation Analyses

Where appropriate based on the invariance analyses, the datasets were pooled for convergent validity analyses using zero-order correlations. Correlations with positive coefficients approaching or exceeding .30 or .50 were considered moderate or large (Cohen, 1988), respectively, and taken as evidence of convergent validity for constructs expected to be positively associated. In keeping with previous research on the Prospective IU and Inhibitory IU distinction, both the zero-order and partial correlations were examined. The zero-order correlations informed the overlapping relationships between Prospective IU and Inhibitory IU, while the partial correlations informed the unique relationships with each correlate. Family-wise error rate was controlled using a Bonferroni correction. As such, a real significance level ($p < .05/150 = p < .00033$) was considered when interpreting bivariate correlations.

RESULTS

CFA Model Fit and Comparison Results

The fit indices for the one-factor model (Figure 1a) were insufficient, $SB\chi^2(54) = 378.77$, $p < .001$; TLI = .822; CFI = .855; RMSEA = .095, 90% CI [.086, .104]. In contrast, fit indices for the two-factor model with correlated factors (Figure 1b) exceeded the recommended minimum, $SB\chi^2(53) = 146.37$, $p < .001$; TLI = .948; CFI = .958; RMSEA = .051, 90% CI [.041, .061], and were significantly better than indices from the one-factor model, $\Delta SB\chi^2(1) = 249.62$, $p < .001$. The model parameters indicated all items loaded significantly on Prospective IU and Inhibitory IU factors, with all λs exceeding .60, except for Item 3 and Item 4 (see Table 1). The Prospective IU and Inhibitory IU factors were also significantly correlated with a large effect size ($\Phi = .70$), suggesting a common second-order factor.

The two-factor model did not include such a second-order, nor imposed a measurement structure on the factor correlation. As such, item responses reflect only the effect of two separate but redundant common factors that are not necessarily part of the same construct. The two-factor model was functionally equivalent to the second-order factor model (i.e., both models have the same number of free parameters and the same fit to the data); however, as depicted in Figure 1 (panels b and c), the second-order model provided a more compelling representation of the IU construct as well as a more fine-grained representation of the measurement model based on the Schimdt-Leiman Solution (SLS; see Method section).

TABLE 1
Standardized solution for the two-factor model, second-order factor model, and bi-factor model of the IUS-12

		Two-factor model			Second-order factor model				Bi-factor model			
Item	Content	Prospective	Inhibitory	Uniqueness	General	Prospective	Inhibitory	Uniqueness	General	Prospective	Inhibitory	Uniqueness
1	Gli avvenimenti imprevisti mi turbano fortemente [Unforeseen events upset me greatly]	.69	–	.73	.53	.40	–	.75	.80	–.51	–	.32
2	Per me è frustrante non disporre di tutte le informazioni di cui ho bisogno [It frustrates me not having all the information I need]	.70	–	.74	.54	.40	–	.74	.68	.01	–	.73
3	Si dovrebbe sempre guardare in avanti così da evitare le sorprese [One should always look ahead so as to avoid surprises]	.50	–	.87	.40	.30	–	.87	.49	.13	–	.86
4	Un piccolo evento imprevisto può rovinare ogni cosa, anche con la miglior pianificazione [A small unforeseen event can spoil everything, even with the best planning]	.38	–	.92	.30	.23	–	.93	.36	.03	–	.93
5	Voglio sempre sapere cosa mi riserva il futuro [I always want to know what the future has in store for me]	.65	–	.75	.53	.40	–	.75	.65	.25	–	.72
6	Non sopporto di essere colto di sorpresa [I can't stand being taken by surprise]	.64	–	.77	.50	.38	–	.78	.62	.13	–	.77
7	Dovrei essere in grado di organizzare ogni cosa in anticipo [I should be able to organize everything in advance]	.63	–	.79	.52	.39	–	.76	.64	.27	–	.72
8	L'incertezza mi impedisce di vivere pienamente la vita [Uncertainty keeps me from living a full life]	–	.70	.70	.61	–	.34	.71	.56	–	.42	.72
9	Quando è il momento di agire, l'incertezza mi paralizza [When it's time to act, uncertainty paralyses me]	–	.76	.71	.66	–	.37	.65	.45	–	.67	.59
10	Quando sono incerto non riesco a procedere molto bene [When I am uncertain, I can't function very well]	–	.69	.79	.60	–	.34	.73	.47	–	.50	.73
11	Anche il più piccolo dubbio può impedirmi di agire [The smallest doubt can stop me from acting]	–	.74	.74	.64	–	.36	.68	.46	–	.59	.67
12	Devo fuggire da tutte le situazioni incerte [I must get away from all uncertain situations]	–	.64	.81	.56	–	.32	.77	.52	–	.36	.77

Note. IUS-12 = Intolerance of Uncertainty Scale short form.

The second-order model results indicated that the Prospective IU and Inhibitory IU factors significantly mediated the effect of the second-order General IU factor, upon which Prospective IU and Inhibitory IU loaded significantly (λs were .80 and .83, respectively). Item factor loadings on Prospective IU and Inhibitory IU factors in the SLS represented item-factor partial correlations, controlling for the effect of the second-order General IU factor (see Table 1). Item factor loadings on the second-order factor represented the indirect effect of General IU on item responses. The λs consistently exceeded .30, except for Item 3, and in most cases approached .40. All items had higher loadings on the second-order General IU factor than on first-order factors. Together, the second-order General IU factor and the two first-order factors accounted for 70% and 30% of the IUS-12 variance, respectively, suggesting the items may better reflect overlap within the broad construct than differences therein.

Despite approaching the good fit for most indexes, the second-order factor model did not provide a substantial improvement compared to the standard two-factor model with correlated factors. In contrast, the bi-factor model not only had an excellent fit to the data, $SB\chi^2(42) = 61.96$, $p = .024$; TLI = .986; CFI = .991; RMSEA = .027, 90% CI [.010, .040], but was also a significant improvement, $\Delta SB\chi^2(1) = 298.90$, $p < .001$. The standardized solution revealed, however, that the Prospective IU factor failed to load the items in this model (see Table 1). In contrast, the Inhibitory IU and the General IU factors loaded on the Inhibitory IU items to an approximately equal extent.

Reliability Analysis

The factor loadings and the error term variances reported in Table 1 were used to assess model-based reliability coefficients for the General IU factor and for the Prospective IU and Inhibitory IU factors, both for the second-order and the bi-factor model. The analysis assesses whether the IUS-12 total score or subscale scores were more reliable (for details, see Reise, Bonifay, & Haviland, 2013). In particular, the reliability coefficient omega (ω; i.e., the proportion of variance in the total score that was accounted for by general and specific factors) was compared to the omega hierarchical coefficient (ωh; i.e., the proportion of variance accounted for by the general factor only). The ω and ωh provided close estimates for the bi-factor model (.86 and .75, respectively), as well as for the second-order factor model (.84 and .69, respectively). The results suggested that, across models, prospective and inhibitory latent factors were not contributing substantially to reliability of the total score variance. Following Reise et al., the ω coefficient was also calculated separately for Prospective and Inhibitory IU factors. The results were fairly high values for the bi-factor model (.75 and .75, respectively), as well as for the second-order factor model (i.e., .75 and .79, respectively). Nevertheless, when compared to the respective omega scale coefficients (ωs; i.e., the proportion of variance accounted for by each of the first-order or group factors only) the coefficients fell remarkably, especially for Prospective IU in the bi-factor model (ωs; .00 and .40 for Prospective and Inhibitory IU, respectively, in the bi-factor model; .27 and .18 in the second-order factor model). As per the CFA fit indices, the ω analyses also suggest the items may better reflect overlap within the broad construct than differences therein.

Invariance Analyses Results

Configuration equality of the bi-factor model produced fit indices exceeding the recommended minimums, $SB\chi^2(84) = 112.50$, $p < .001$; TLI = .969; CFI = .980; RMSEA = .032, 90% CI [.013, .046], suggesting the number of factors and the factor-loadings were comparable across datasets. Constraining the factor loadings to be equal for items on the general factor also produced fit indices exceeding the recommended minimums, $SB\chi^2(96) = 130.41$, $p < .001$; TLI = .979; CFI = .984; RMSEA = .033, 90% CI [.016, .043]. The indices were not statistically different from those for the configuration equality model, $\Delta SB\chi^2(12) = 18.20$, $p = .10$. Next, we constrained the factor loadings to be equal for items on the general factor and on the group factors. The analysis yielded an overall good fit, $SB\chi^2(108) = 157.49$, $p < .001$; TLI = .973; CFI = .978; RMSEA = .037, 90% CI [.023, .049], but the more constrained model produced significantly worse fit indices, $\Delta SB\chi^2(12) = 18.20$, $p = .10$. Nevertheless, the ΔCFI = .006 indicated the indices were not substantially different (Cheung & Rensvold, 2002). Lastly, we constrained the observed variable means to be equal. The model was acceptable for most fit indices, $SB\chi^2(120) = 268.62$, $p < .001$; TLI = .928; CFI = .948; RMSEA = .041, 90% CI [.029, .053]; however, the indices were significantly worse than the factor loading equality model, $\Delta SB\chi^2(12) = 163.47$, $p < .01$; ΔCFI = .007.

Correlation Analyses Results

The zero-order and partial correlations were calculated between the Prospective IU subscale, the Inhibitory IU subscale, the IU total score, and the available measures for convergent validity, depending on the dataset (see Table 2). As expected, Prospective IU and Inhibitory IU were positively and highly correlated with each other and with the total IU score. Also as expected based on sample sizes and content variations, there was substantial variability in the other correlations. That said, the relationship patterns for the translated IUS-12 subscales and total scores with the other variables were consistent with patterns reported in previous research. For example, the IUS-12 total score had positive zero-order correlations with measures of closely related constructs, such as Emotional and Cognitive Uncertainty, Neuroticism, Need for Cognitive Closure subscales (but not Decision), and D-type curiosity. In contrast, we obtained negative zero-order correlations with Extraversion, Openness to Experience, Desire for Change, and Risk Taking measures. The pattern of zero-order correlation was similar for the total score, Prospective IU, and Inhibitory IU. The analysis of partial correlations produced smaller effect sizes, when controlling for other type IU and for IU total, again indicating substantive redundancy among IUS-12 scores.

DISCUSSION

The current study was designed to evaluate the hypothesis that a hierarchical multifaceted factor structure would have a good fit using a large Italian sample of undergraduates. Previous research has supported the superiority of a two-factor model with correlated factors relative to

TABLE 2

Means, standard deviations, alphas, zero-order and partial correlations between Prospective IU and Inhibitory IU subscales of IUS-12.
(N = 360 for dataset A, 167 for dataset B, and 82 for dataset C)

Scale	Construct	*M*	*SD*	*N*	Zero-order *r*						Partial r^a				Partial r^b			
					IU total		Prospective IU		Inhibitory IU		Prospective IU		Inhibitory IU		Prospective IU		Inhibitory IU	
IUS-12	IU total	29.69	8.06	672	1.00													
	Prospective IU	18.79	5.02	672	.91	**	1.00											
	Inhibitory IU	10.90	4.03	672	.86	**	.58	**	1.00									
EPQ-R	Psychoticism	7.26	3.61	324	–.09		–.16	**	–.01		–.19	**	.12	*	–.18	**	.14	*
	Extraversion	14.93	4.55	324	–.20	**	–.20	**	–.18	**	–.15	**	–.03		**–.51**		.07	
	Neuroticism	12.66	4.93	324	**.45**	**	**.41**	**	**.41**	**	.18	**	.19	**	**–.41**		–.01	
	Lie	9.87	2.11	324	.03		.07		–.01		.14	*	–.10	†	.13	*	–.12	*
NCCS	Order	3.34	0.88	324	**.41**	**	**.44**	**	**.33**	**	**.32**	**	.04		.18	**	–.11	*
	Ambiguity	3.62	0.84	324	**.50**	**	**.47**	**	**.46**	**	.23	**	.21	**	.00		.00	
	Closure	2.49	0.63	324	.27	**	.27	**	.26	**	.13	*	.10	†	.00		–.02	
	Predictability	3.15	0.88	324	**.52**	**	**.52**	**	**.44**	**	**.33**	**	.13	*	.10	†	–.11	*
	Decision	3.18	0.89	324	–.22	**	–.11	*	**–.30**	**	.15	**	–.31	**	.27	**	–.23	**
URS	Emotional Uncertainty	31.99	7.65	324	**.61**	**	**.52**	**	**.58**	**	.21	**	**–.33**	**	–.12	*	.06	
	Desire for Change	46.78	7.06	324	**–.34**	**	**–.34**	**	**–.28**	**	–.21	**	–.05		–.08		.08	
	Cognitive Uncertainty	44.67	7.55	324	**.46**	**	**.51**	**	**.36**	**	**.40**	**	–.07		.25	**	–.17	**
RT-18	Behavior	4.22	2.72	163	**–.22**	**	**–.24**	**	–.15	†	–.18	*	–.03		–.08		.08	
	Assessment	2.75	2.23	164	–.16	*	–.09		**–.20**	*	.02		–.18	*	.12		–.12	
ECS	I-type curiosity	16.07	2.48	164	–.10		–.11		–.06		–.10		.01		–.06		–.05	
	D-type curiosity	12.88	3.19	163	**.26**	**	**.22**	**	**.25**	**	.11		.15	†	–.04		–.04	
BFI	Extraversion	26.41	5.75	79	–.39	**	–.31	**	–.37	**	–.16		–.26	*	.07		–.07	
	Agreeableness	33.73	5.17	79	–.07		–.08		–.04		–.09		.00		–.06		.06	
	Conscientiousness	33.52	6.18	79	.06		.16		–.05		.20	†	–.15		.20	†	–.20	†
	Neuroticism	24.68	5.83	79	**.51**	**	**.41**	**	**.48**	**	.23	*	.33	**	–.05		.05	
	Openness to Experience	38.18	6.33	79	–.38	**	–.36	**	.30	*	–.25	*	–.12		–.07		.07	

Note. Bold type correlations are significant at p < .00033, after controlling for family-wise error bias (Bonferroni method); [a] = controlling for the other IU factor; [b] = controlling for the General IU factor; EPQ-R = Eysenck Personality Questionnaire-Revised; NCCS = Need for Cognitive Closure scale; URS = Uncertainty Response Scale; RT-18 = Risk Taking-18 measure; ECS = Epistemic Curiosity Scale; BFI = Big Five Inventory. ** p < .01. * p< .05. † p < .10.

an unitary model (see, for a review, Carleton, 2016b; Hong & Lee, 2015). The two factors have demonstrated differential utility in different clinical samples, but continue to be highly correlated and the IUS-12 is often treated as unitary (Hong & Lee, 2015); as such, previous research appears to imply the possibility of a hierarchical multifaceted structure for the IUS-12 that parses general and specific variance components in personality ratings.

The current results supported a bi-factor model as best accounting for the IUS-12 measurement model, with Prospective IU and Inhibitory IU as group factors and with a General IU factor unrelated to the aforementioned group factors. In particular, given the relatively high factor intercorrelation of Prospective and Inhibitory IU in the standard two-factor model, the General IU factor was highly reliable and accounted for about 75% of the IUS-12 total score variance. The result approximates Hale et al. (2016), wherein as much as 80% of variance in IUS-12 scores was accounted for by a general factor. The current results were also remarkably similar to Hale et al. in that few items loaded highly on the subscale factors, particularly for Prospective IU. As such, the results warrant caution in using the subscales, which accounted for relatively less variance than the general latent factor.

Regarding comparisons with previous Italian research, unbeknownst to us when our data were collected, Bottesi et al. (2015) tested a two-factor model with oblique factors using a slightly different version of the same scale (Walker et al., 2010). Despite differences in item wording and item selection, the two-factor model was found superior to the single factor model both in our study and in Bottesi et al.; moreover, the factor loading pattern and factor intercorrelations were also similar. Bottesi et al. did not test a second-order factor model or a bi-factor model; nonetheless, their results also supported a multifaceted hierarchical structure for IU in English and Italian samples.

The current results indicate different presentation modes affected the metric invariance of IUS-12 scores, but in line with prior research (see, for a review, Carleton, 2016b; Carleton et al., 2012; Helsen et al., 2013; Hong & Lee, 2015) preserved configural and scalar invariance. As such, scale items presented in different modes can be interchangeably used in correlation analyses as they measure the same latent factors on the same scale; that said, metric variance suggests caution when making inferences about group comparison results based on different presentation modes.

Taken together, the current results suggest that, although a two-factor structure is commonly reported, not only the total score can be used, but may be more appropriate for assessments. That said, substantial evidence has supported differential relationships between Prospective IU, Inhibitory IU, and other constructs (Hong & Lee, 2015). For example, Inhibitory IU may relate more to anxiety sensitivity (Fetzner, Horswill, Boelen, & Carleton, 2013) and fear of negative evaluation (Whiting et al., 2014) than does Prospective IU. There have also been disparate results regarding differential relationships with personality variables (e.g., Berenbaum et al., 2008; Mahoney & McEvoy, 2012a; McEvoy & Mahoney, 2011).

The current results also provide initial psychometric support for the Italian translation of the IUS-12. The scale has produced comparable psychometrics properties to the French (e.g., Freeston et al., 1994) and Dutch language versions (Helsen et al., 2013), as well as within previous Italian studies (Bottesi et al., 2015). Moreover, the current scale produced endorsement rates comparable to published results from English samples (see, for a review, Carleton, 2016b; Carleton et al., 2012). The Italian IUS-12 used in the present study also demonstrated convergent validity with measures of personality, need for closure, uncertainty responses, curiosity, and risk taking. In particular, when correcting bivariate correlations for family-wise error, the IUS-12 total score was again strongly characterized in terms of neuroticism, need for order and predictability, intolerance of ambiguity, emotional and cognitive reactions to ambiguity (Berenbaum et al., 2008; Boelen & Carleton, 2012; Helsen et al., 2013; Khawaja & Yu, 2010; Kruglanski & Webster, 1996; Rosen & Knäuper, 2009; Volz & Gigerenzer, 2012).

Notwithstanding methodological strengths and compelling results, the current study has several limitations that provide directions for future research. First, the robust psychometrics should be replicated with an independent sample and then further assessed in a variety of other languages. Moreover, investigating test-retest reliability and assessing measurement invariance across age and gender groups are items which remain on the research agenda (see also Hale et al., 2016). Second, the hierarchical multifaceted structure should be assessed using other measures of IU, such as the Intolerance of Uncertainty Index (Gosselin et al., 2008) and the Disorder-Specific Intolerance of Uncertainty Scale (Thibodeau et al., 2015). Third, the current results should be assessed in clinical or community samples. Fourth, additional research is needed to explore criterion validity for IU; currently, discussions of causality remain speculative and warrant longitudinal research and experimental manipulations. Fifth, the current data are based on self-report measures. Future research should include multimodal assessments of IU and related constructs. In the interim, the Italian IUS-12 is a psychometrically supported measure of IU, representing a hierarchical multifaceted construct useful for exploring individual differences and conducting both transdiagnostic and cross-cultural research.

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