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Psychometric properties of the Comic Style Markers – Portuguese version: Applying bifactor and hierarchical approaches to studying broad versus narrow styles of humor

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Abstract

Given the relevance of humor for psychosocial assessment and promoting positive functioning, it is important to understand the relationship between humor and personality. A recent framework for describing individual differences in humor posits eight comic styles that can be measured using the Comic Style Markers (CSM). In total, 665 Portuguese adults ($M_{age} = 32.1$ years) completed the CSM and Cloninger's Temperament and Character Inventory. CFAs supported modeling the CSM as a bifactor model. Bifactor indices suggested a general humor factor could be interpreted as a unidimensional construct, but that CSM items are multidimensional. A hierarchical analysis showed the styles could be represented at several levels of abstraction. A SEM analysis suggested certain styles had distinct associations with personality dimensions. These findings suggest that the use of certain styles (namely wit, sarcasm, and cynicism) was related to individual differences in temperament and character beyond a person's overall humor potential.

Psychometric properties of the Comic Style Markers – Portuguese version: Applying bifactor and hierarchical approaches to studying broad versus narrow styles of humor

1 Introduction

Humor, as a broad construct and fundamentally social phenomenon, reflects anything said or done that is perceived as funny and makes others laugh, the mental processes involved in formulating and perceiving amusing stimuli, and the associated affective responses (Martin, 2007). A current interest in personality research is understanding individual-differences in humor; that is, humor as a stable trait that captures a person's disposition for humor-related thoughts, feelings, and behaviors (Ruch 2012; Ruch 2008). Such research is concerned with describing how people differ in their understanding, appreciation, and usage of humor, and how differences in humor are relevant for wellbeing and human functioning (Martin et al. 2003; Ruch and Heintz 2013). Indeed, humor is an effective tool for cultivating and enhancing positivity and mental health (Schneider et al. 2018).

Within this body of research, individual-differences in humor have been captured via the description of *styles* (Ruch et al. 2018; Martin et al. 2003). Styles capture typical ways of thinking, feeling, and acting, and vary in terms of their characteristics and level of abstraction (Ruch et al. 2018). More abstract styles (such as light versus dark styles) reflect broad ranges of different behaviors. In contrast, styles at the lower level of abstraction, capturing more elementary types and qualities of humor (e.g. wit, sarcasm, irony), reflect more specific behaviors that can be trained and modified. These lower-level styles, and particularly their accurate measurement, are the primary focus of the present paper.

1.1 *Comic styles and the Comic Style Markers*

A recent framework for describing humor styles at a lower level of abstraction refers to eight *comic styles* (Ruch et al. 2018). These comic styles are fun (joking and jesting to spread good mood), benevolent humor (acceptance of imperfections, smiling at adversity), nonsense (intellectual play with sense and nonsense), wit (skillful use of humor to generate quick punchlines), irony (saying things differently than meant to exclude non-insiders), satire

(corrective humor, using ridicule to better the world), sarcasm (ruthless exposure to hurt others), and cynicism (mockery to highlight weakness). Each comic style can be characterized in terms of its intention, object, attitude of the agent as subject, behavior toward others, ideal audience, method, and linguistic peculiarities (see Ruch, 2012). Unlike more general aggregate humor styles (e.g., Craik, Lampert & Nelson 1996; Martin et al. 2003), the eight comic styles offer a narrower, more fine-grained representation of individual-differences in humor. These comic styles are measured using the Comic Style Markers (CSM; Ruch and Heintz et al. 2018).

Despite its recent popularity in the humor literature, it remains critical that researchers submit the CSM to rigorous psychometric testing. This includes translating the CSM for use in cross-cultural research, and examining the latent structures of these translated measures at both the item- and scale-levels. This is necessary because people from different countries may have different perceptions and usages of humor styles (Chen and Martin, 2007; Jiang et al., 2019). For example, Chinese students were less likely to use humor as a coping strategy against stress compared to Canadian students (Chen and Martin, 2007) with a similar effect observed when comparing students from Singapore and America (Nevo et al., 2001). Research has also shown that individuals from different cultural backgrounds have different mean scores for measures of broad humor styles. Americans, for example, have been shown to have higher scores than Egyptians and Lebanese for the self-enhancing and self-defeating styles (Kalliny et al. 2006). Given that humor is culturally tinted (Jiang et al. 2019), it follows that the quality, usage and structure of the eight comic styles may differ across cultures. That said, cross-sectional studies have shown that two specific comic styles, benevolant, and corrective humor, are broadly consistent across multiple countries (Heintz et al. 2018; Heintz et al. 2020). As far as the authors are aware, other than a comparison of German and English languages versions of the CSM by Ruch, Heintz et al. (2018), there is little research exploring cultural differences in the full set of eight comic styles, meaning that cross-cultural studies are sorely needed. Before conducting this type of research, the CSM must be translated and appropriately adapted for use in multiple cultures. Each translated version of the CSM requires thorough psychometric testing, including

tests of its latent structure, as there is no guarantee that the underlying comic styles being measured in the original version will transfer to the translated versions.

Another limitation of current research is that the factorial validity of the CSM items has not been well established. Indeed, only a small number of studies have examined whether the CSM items measure the comic styles they were intended to measure (Ruch et al. 2018; Dionigi, Duradoni & Vagnoli 2021). The study of Ruch et al. (2018) included two confirmatory factor analyses (CFAs) using independent samples. The model tested, a correlated eight-factor model, had an acceptable fit to the data. However, Ruch and Heintz et al. (2018) did not test alternative models with CFA, which is important given their acknowledgment that the comic styles may reflect facets of a higher-order general (g) factor. The study of Dionigi et al. (2021) tested independent unidimensional models for each comic style but did not test models of how these latent constructs are related.

There are two types of model that can describe multidimensional constructs (Chen, West & Sousa 2006). In higher-order models, broad factors explain the communality of narrow factors. Such a model applied to the CSM hypothesizes that a general factor describing overall humor potential accounts for the relationships between the eight narrower comic styles. In bifactor models, a general factor explains the communality of items, and specific factors explain unique variance among subsets of items independent of the general factor. Such models are based on the assumption that the broad and narrower factors are of theoretical interest. For the CSM, a bifactor model hypothesizes that a general factor explains common variance in a person's response to all items, but also that the items for each comic style share additional variance explained by specific factors. Bifactor models are particularly useful because they can be used to study the role of broad and narrow factors in predicting external outcomes, and because they help provide conceptual clarity by identifying narrow factors that are redundant after considering common variance among all narrow factors (Chen et al., 2012). Because research has yet to clarify the best latent factor structure for the CSM, the first aim of the study was to compare competing structures (specifically a first-order correlated factors model, a

second-order model, and a bifactor model) using CFA. If comic styles do indeed reflect facets of a higher-order general factor (Ruch, Heintz et al., 2018), it follows that the first-order model should have the least satisfactory fit. We did not have strong reasons to predict which of the second-order or bifactor models would be the most appropriate.

Research Question 1: What is the item-level latent structure of the Portuguese CSM?

H1: The Portuguese CSM can be modeled adequately with a second-order CFA model.

Ruch and Heintz et al. (2018) argued the eight comic styles are conceptually distinct, but also acknowledged understanding the latent structure of comic styles at higher levels of abstraction (that is, via the aggregation of multiple styles) might be theoretically relevant. To date, two studies (Ruch 2012; Ruch et al. 2018) have considered this research question using a relatively uncommon, but theoretically informative, hierarchical approach to latent structural analysis (Goldberg, 2006). Unlike typical latent structure research, which predetermines an optimal number of factors to extract using methods such as parallel analysis, Goldberg's approach does not commit to an optimal solution. Instead, this approach involves performing a series of principal component analyses, in each step adding a component, starting with a one un-rotated component solution and terminating when no further theoretically relevant factors emerge.

Applying this method to the eight comic styles, Ruch (2012) and Ruch and Heintz et al. (2018) found evidence of a broad general factor of humor, which first splits into two factors representing negative humor and positive humor. In the following step, the positive humor decomposed into an "enjoyment of humor" factor (comprising Fun and Nonsense) and a more profound "good" humor factor (comprising Wit and Benevolent Humor), while the negative humor factor remained constant (comprising Irony, Sarcasm, and Cynicism). Satire, which is characteristically aggressive but paired with good intentions, was found to have similar loadings on the good and negative humor factors. It was noteworthy that in these studies the hierarchical process was stopped before the point where the extracted factors reflect distinct narrow comic styles (i.e. before the eight-factor solution), meaning that the full hierarchical structure of comic

styles, from least to most abstract, has yet to be described. Moreover, because the structure of comic styles may vary across cultures (Chen and Martin, 2007) it will be useful to examine whether the structure of comic styles observed by Ruch and Heintz et al. (2018) replicates in culturally distinct samples. Indeed, it has been argued that the best way to compare latent structures across languages is at different hierarchical levels (Goldberg & Somer 2000; Goldberg 2006). Consequently, the second study objective was to explore the hierarchical structure of comic styles.

Research Question 2: What is the scale-level latent structure of the Portuguese CSM?

1.2 *Comic styles and personality*

Recent studies have investigated the associations between humor styles, including the eight comic styles, and personality traits (Ruch, Wagner & Heintz 2018; Ruch et al. 2018; Dionigi, Duradoni & Vagnoli 2021). Overall, these studies revealed a pattern of weak-to-moderate associations between various personality traits and humor styles. For example, studies focused on the 'Big Five' personality traits found extraversion (positive emotionality) was positively correlated with light comic styles such as fun, wit, and benevolent humor, while neuroticism was linked to dark comic styles such as sarcasm and cynicism (Dionigi, Duradoni & Vagnoli 2021; Ruch et al. 2018).

This body of work is characterized by its focus on popular taxonomic models of personality traits, namely the Five-Factor Model (FFM; Dionigi, Duradoni & Vagnoli 2021; Ruch et al. 2018) and Eysenck's PEN model (Ruch, Wagner & Heintz 2018). Such traits capture between-person variability in emotional, cognitive, and behavioral tendencies, meaning results from these studies help account for differences in comic styles between persons. However, dimensions from taxonomic personality models like the FFM are multifaceted and not etiologically independent (Johnson & Krueger 2004), meaning different people can record the same level of a trait (e.g., neuroticism) for different reasons (Cervone 2005). Research on personality and humor can, therefore, benefit from expanding current understanding of how the

specific components, subsystems, and processes of personality are linked to the expression of comic styles within individuals. To do this, it is necessary to adopt personality models in which personality is explained by reference to specified underlying psychological systems rather than higher-level abstract constructs (Cervone 2005). One such model with extensive empirical validation is Cloninger's Psychobiological Model of personality (Zwir et al. 2020a; Zwir et al. 2020b; Zwir et al. 2019; Cloninger 2004).

According to Cloninger's Psychobiological Model, personality corresponds to the dynamic organizations that regulate the way people learn to shape and adapt to their environments (both internal and external). At its most basic level, this model integrates two distinct domains of personality: temperament and character (Cloninger 2004; Cloninger et al. 1993; Cloninger et al. 2019). The four temperament dimensions of this model capture the innate dispositions that shape how people automatically and unconsciously learn to behave, react emotionally, and form attachments: novelty seeking (tendency to respond to reward), harm avoidance (tendency to respond to aversive stimuli), reward dependence (sensitivity to reward, including social approval), and persistence (tendency to resist behavioral extinction). In turn, three character dimensions reflect organizations of higher-order sociocognitive processes that shape what people make of themselves intentionally and/or creatively and regulate the temperamental dimensions and their conflicts in life situations. Such regulation occurs in relation to different concepts of the self: the self as an autonomous individual with values and standards (self-directedness), as a part of a society/community (cooperativeness), and as part of a wider reality that transcends the individual (self-transcendence).

Descriptors of individuals with high levels of the temperament and character dimensions (Cloninger 1987) are suggestive of some associations with comic styles. For example, people high in reward dependence can be described as sociable and warm, which suggests they may be more inclined to the lighter rather than darker comic styles. Overlap between the FFM and Cloninger's dimensions help inform preliminary predictions. For example, neuroticism is positively correlated with harm avoidance and negatively correlated

with self-directedness (De Fruyt et al. 2000). Thus, in alignment with prior studies (e.g. Ruch, Heintz, et al., 2018; Ruch, Wagner, et al., 2018) we anticipated that darker styles such as sarcasm and cynicism might be linked to increased harm avoidance and lower self-directedness. Extraversion (linked to lighter styles) is predictive of lower harm avoidance, and increased novelty seeking, reward dependence and cooperativeness (De Fruyt et al. 2000). Therefore, we expected that lighter comic styles might be linked to these specific dimensions. Beyond these basic predictions, however, we chose to explore the specific associations between the eight narrow comic styles and the dimensions of temperament and character.

Finally, all past studies testing the links between personality traits and humor (e.g. Ruch, Heintz, et al., 2018) examined correlations between individual comic styles and personality traits. This approach is limited because comic styles are, theoretically, narrower facets of a broader humor factor, meaning it is difficult to disentangle the unique contributions of the specific comic style and broader factor to any significant correlation (Chen et al., 2012). As considered above, a bifactor approach to this issue will be advantageous because it can be used to test, simultaneously, the association of a personality trait with the general humor factor and the unique contributions of the narrower comic styles above and beyond the general factor. Consequently, we decided to use a bifactor approach to testing the associations between the dimensions of the psychobiological model and comic styles.

Research Question 3: How are comic styles related to psychobiological personality traits?

H2: Darker styles such as sarcasm and cynicism will be linked to increased harm avoidance and lower self-directedness.

H3: Lighter comic styles such as fun and benevolent humor will be linked to lower harm avoidance and higher novelty seeking, reward dependence, and cooperativeness.

2 Methods

2.1 *Participants*

We recruited undergraduate students at the authors' university from several degree programs and provided each with 10 questionnaire packs to distribute to friends and family (specifying only that these people should be adults). Based on these procedures, a total of 767 individuals agreed to participate. To be eligible for the study, participants had to provide informed consent, to be able to read Portuguese. For data to be included in the analyses, participants had to have less than 25% missing data for the main study variables and to respond correctly to at least four of the five 'attention-check' directed response items included in the survey.

Based on these criteria, the final study sample comprised 665 participants. Based on typical rules-of-thumb for CFA and SEM (e.g., 10 subjects per indicator variable; Nunnally & Bernstein 1967) and recommendations from monte-carlo studies (e.g., $n \geq$ 200-500; Bandalos 2014), we determined this sample size was acceptable. The mean age of these individuals was 32.1 years (SD = 15.53 years; $range$ = 17 – 88 years) with the central 50% aged between 19.0 years (1st quartile) and 44.0 years (3rd quartile). The sample comprised 70% women and 29.6% men (0.3% missing data). Most participants reported a Portuguese nationality (95%; 1.5% missing data). Other reported nationalities were Brazilian, Angolan, Luxembourgish, and French. Nearly half of the sample were full-time university students (44%), with the remainder either employed (35%), unemployed (4%), or retired (8%).

2.2 *Study variables and measures*

Participants completed a battery of questionnaires including sociodemographic questions and measures of personality, comic styles, values, virtues, political orientation, quality of life, emotional wellbeing, and family functioning (for related works, see Moreira, Inman & Cloninger, submitted). Of these, only the following were considered in the present article:

2.2.1 *Comic styles.* Participants completed the Portuguese version of the Comic Style Markers (CSM; Ruch, Heintz, et al., 2018) (see Section 2.3.2 for translation procedure). The 48-item CSM comprises eight subscales (six items per style), each reflecting a distinct comic style: fun (e.g., "I am a funny joker"), irony (e.g., "Whoever understands my irony is, along with me,

superior to those who don't understand it"), wit (e.g., "I have the ability to tell something witty and to the point"), sarcasm (e.g., "Biting mockery suits me"), benevolent humor (e.g., "When my humor is aimed at human weaknesses, I include both myself and others"), satire (e.g., "I parody people's bad habits to fight bad and foolish behavior"), nonsense (e.g., "I like nonsensical humor"), and cynicism (e.g., "I tend to show no reverence for certain moral concepts and ideals, but only scorn and derision"). All items are scored using a seven-point Likert scale from 1 (*strongly disagree*) to 7 (*strongly agree*). Ruch, Heintz et al. (2018) found adequate reliability coefficients (Cronbach's alphas) for the CSM subscales, ranging between .66 and .89 in German-speaking samples and .79 and .88 in English-speaking samples.

2.2.2 *Temperament and character.* We measured personality using a Portuguese version of the Revised Temperament and Character Inventory (TCI-R) (Cloninger 1999; Moreira et al. 2017). This inventory has 240 items that measure the seven dimensions from Cloninger's psychobiological model: novelty seeking, harm avoidance, reward dependence, persistence, self-directedness, cooperativeness, and self-transcendence. All items are rated using a five-point Likert scale from 1 (*definitely false*) to 5 (*definitely true*). In the present sample, the values for omega ranged from .79 (novelty seeking) to .92 (harm avoidance).

2.3 *Procedures*

2.3.1 *Ethical considerations.* Approval was granted by the author's university Ethical Review Committee, ensuring the study was performed per the Ethical Standards described in the 1964 Declaration of Helsinki. Individuals were only eligible for participation if they provided informed consent. It was made explicit to all individuals that participation was voluntary and that they could withdraw from the study at any time without consequence. All data was fully anonymized.

2.3.2 *Translation of the CSM into Portuguese from English.* First, a native speaker of Portuguese who is an author of the present article (PM) and proficient in English translated the CSM into Portuguese. This first draft of the Portuguese CSM was then reviewed by PM

together with a second native speaker of Portuguese from the research team who is also proficient in English. Both PM and the second translator are academics with PhDs in Psychology. In this review process, any discrepancies in item interpretation and translation were discussed and resolved. The agreed-upon translation of the Portuguese CSM was then sent for back-translation by a third individual who is Portuguese but has lived and worked in the UK as an academic (PhD in Psychology) for over 15 years and is therefore essentially bilingual. This individual was not familiar with any version of the CSM. Finally, PM compared the back-translated version of the CSM to the original English version to evaluate semantic equivalence.

2.3.3 *Data collection.* Questionnaires were completed in paper format. Participants who were students and recruited at university completed the questionnaires independently during class. This process was supervised by the class teacher and a member of the research team. Participants recruited via referral were asked to complete the questionnaires independently and then return them to the research team. Participants were not rewarded for their involvement.

2.3.4 *Statistical analysis.* All analyses were performed using R (version 3.6.1; R Core Team, 2019). Raw data and R code are available at https://osf.io/qyg3b/. The amount of missing data for the CSM and TCI-R was small, with 98% and 87% of participants having either no missing data or only one missing item. There was not sufficient statistical evidence that missing data for the CSM or TCI-R were not missing completely at random (MCAR), and we, therefore, used multiple imputation by chained equations to impute missing data (*mice* package; Buuren & Groothuis-Oudshoorn 2011).

For Research Question 1, we tested three plausible structures of the CSM using confirmatory factor analyses (CFA): a correlated first-order model, a second-order model, and a bifactor model (see Figure 1). For this, we used the *lavaan* package (Rosseel 2012). These analyses were conducted using the robust maximum likelihood (MLR) estimator. We assessed model fit using several indicators and heuristics: (a) CFI ≥ .95 (Hu and Bentler 1999); (b) RMSEA < .08 (Browne and Cudeck 1992); and (c) SRMR < .08 (Hu and Bentler 1999). We supplemented the bifactor model with several bifactor indices. Omega (ω) estimates the

proportion of variance in the general factor explained by all sources of variance. The same logic

was applied to calculate an index of reliability for each specific factor (ω_S). Omega hierarchical

(ω_H) represents the proportion of systematic variance in total scores explained by the general

factor (Reise et al. 2010). When ω_H is larger than .75, scale composite scores can be interpreted

as a measure of a single construct (Reise et al. 2013). The logic of ω_H was also applied to

specific factors to measure the proportion of reliable variance after accounting for variability

explained by the general factor (ω_{HS}). We also calculated the Explained Common Variance

(ECV) index in conjunction with the Percentage of Uncontaminated Correlations (PUC)

(Rodriguez et al. 2016). When ECV is larger than .70, factor loadings from a unidimensional

model are a good approximation of the factor loadings on a general factor from a bifactor

model. PUC influences the parameter bias of the unidimensional solution. The combination of

PUC > .70 and ECV > .70 suggests the common variance of an instrument can be interpreted as

essentially unidimensional (Rodriguez, Reise & Haviland 2016).

To address Research Question 2, we used Goldberg's (2006) hierarchical approach to

investigate the scale-level structure of comic styles. With this approach, there is no requirement

to predefine a maximum number of factors to extract, and the process can continue until the

point an emergent component is not associated with the highest loading for any variable.

However, we explored the full hierarchical structure because we were interested in a small set of

variables (i.e. mean scores for the eight comic styles). Thus, a series of eight PCAs (*psych*

package; Revelle 2020) were run on normative data to evaluate solutions with increasing

numbers of components. The first analysis estimated the un-rotated principal component (a one-

factor solution) and in each subsequent PCA (using an orthogonal Varimax rotation) we added

one factor more until finally testing an eight-component solution. For each solution, we

calculated component scores and used these to compute correlations between components at

adjacent levels of the hierarchy.

Finally, for Research Question 3, we used structural equation modeling (SEM; also

lavaan) to estimate the relationships between the CSM and composite indicators of

temperament and character dimensions. Based on the outcome of the CFA to address Research

Question 1, we modeled the CSM with a bifactor structure. External variables were modeled as

a latent factor with a single composite indicator. The unstandardized error variance of each

composite indicator was calculated using the equation $(1-r_{xx}) \times var(x)$; where r_{xx} is Cronbach's

alpha for the composite score and $var(x)$ is the variance. The latent factor representing the

external variable was then allowed to correlate with the general and specific factors.

3 Results

3.1 *Preliminary analyses*

A key assumption of CFA is multivariate normality. A practical solution to testing this is to

check the assumption of univariate normality of residuals because this is a necessary condition

for multivariate normality (Field 2012). The univariate distributions shown in Figure 2 were

indicative that study variables were approximately normally distributed. Interested readers can

find residual plots for the CSM scales in Supplementary Materials. These further confirmed that

there were no major deviations from normality.

FIGURE 2

3.2 *Research question 1: What is the item-level factor structure of the Portuguese CSM?*

3.2.1 *CFA*. Table 1 shows fit indices for the three models tested. An inspection of fit indices

showed that all models fell short of the threshold prescribed for CFI. These lower values were

not unexpected given that RMSEA for the null model was $< .158$, meaning incremental fit

indices including CFI are less informative (Kenny et al. 2015).

TABLE 1

     The correlated-factors model was inadmissible because the covariance matrix of latent

variables was not positive definite. It was evident by comparing RMSEA, SRMR, and X^2/df

values that the bifactor model had the best fit of the remaining two models. The standardized

factor loadings from the bifactor model are shown in Table 2. Because the second-order model

is nested in the bifactor model, we compared the two models using the chi-squared test. This test indicated that the bifactor model (df = 1032, BIC = 108671, X^2 = 4340.2) was indeed significantly better than the second-order model (df = 1072, BIC = 108902, X^2 = 4831.2; ΔX^2 = 336.6, $p < .001$).

TABLE 2

3.2.2 *Bifactor indices.* Bifactor indices are also presented in Table 2. Values for coefficients ω and $ω_S$ were all > .70, showing the general and specific factors of the bifactor model had good reliability. We assessed whether a CSM total score can be interpreted as a measure of a broad humor construct, despite multidimensionality, by calculating $ω_H$. For our data, $ω_H$ was .90, which was above the cut-off prescribed by Reise, Bonifay, et al. (2013). For all specific factors, the values for $ω_{HS}$ were lower than for $ω_H$, which indicated much of the variance for each was attributed to the general factor. Values for ECV and PUC were .63 and .89 respectively. The ECV value indicated that 63% of the common variance in items was attributable to the general factor, but because it was below the threshold of .70 (Rodriguez et al. 2016), researchers should model the CSM using the bifactor approach for SEM and Item Response Theory (IRT) analysis; that is, the multidimensionality disqualifies interpreting the instrument as being primarily unidimensional.

3.3 *Research question 2: What is the scale-level latent structure of the Portuguese CSM?*

Figure 3 and Table 3 present the full hierarchical structure of the eight comic styles. The relations between components indicate that a *general factor* (the first un-rotated principal component) splits into two components reflecting a *light style* (factor 2-1) and a *dark style* (2-2). This dark style factor then stays largely unchanged until the final stages of the hierarchy. In step three of the hierarchy, the light style component subdivides into two components reflecting an *affiliative style* (3-3) and a *reflective style* (3-1). After this point, the higher-order styles decomposed gradually into their eight component comic styles. However, it was noteworthy that two more specific higher-order styles emerged in the later stages. Namely, the reflective

style decomposed into components reflecting a *virtuous style* (4-3) and *nonsense* (4-4), and the

affiliative style decomposed into components reflecting a *playful style* (5-5) and *irony* (5-3).

FIGURE 3

TABLE 3

3.4 *Research question 3: How are comic styles related to psychobiological personality traits?*

Factor correlations between personality traits and the bifactor model are presented in Table 4.

The general factor had significant, albeit mostly weak, positive associations with novelty

seeking ($r = .31$), persistence ($r = .14$) and self-transcendence ($r = .16$), and a significant

negative association with self-directedness ($r = -.18$).

TABLE 4

The eight specific factors were differently associated with the various personality traits

after accounting for variation in the general factor. Most of the correlations were weak ($< |.20|$).

However, wit was negatively correlated with harm avoidance ($r = -.37$), and positively

correlated with persistence ($r = .44$), and self-transcendence ($r = .26$). Benevolent humor was

also positively correlated with persistence and self-transcendence ($r = .25$ and $.29$ respectively),

although these fell short of being statistically significant. Irony was positively associated with

self-transcendence and negatively associated with novelty seeking, although these values were

also nonsignificant. In contrast, sarcasm was negatively correlated with reward dependence ($r =$

$-.28$), self-directedness ($r = -.24$) and cooperativeness ($r = -.52$). Cynicism was also negatively

correlated with self-directedness ($r = -.22$) and cooperativeness ($r = -.43$), and satire was

negatively correlated with cooperativeness ($r = -.24$). Finally, it was apparent that fun and

nonsense did not have practically significant correlations with personality traits.

4 Discussion

4.1 *The Portuguese CSM should be modeled as a bifactor model*

The first aim of the study was to examine the item-level latent structure of the Portuguese CSM by testing a series of theoretically possible models with CFA. This study represents the first to test the fit of higher-order models (in this case a second-order model versus a bifactor model) which is important because prior works suggest the eight comic styles can be represented by higher-level factors at various levels of abstraction, including a broad general factor describing overall humor potential; that is, variance that overlies the pattern of relations among comic styles (Ruch 2012; Ruch et al. 2018). Consistent with this past work, and our first hypothesis, we found that the comic styles could indeed be modeled as facets of a broader multifaceted construct representing overall humor potential. Moreover, we found that a bifactor model offered the most accurate description of our data. Bifactor models are considered superior to second-order models because, among other things, they can help identify whether facets of a construct still exist after partialling out a general factor, and consequently enrich conceptual understanding (Chen et al. 2012). Our bifactor model showed that Irony and Benevolent humor specific factors did not explain additional variance above and beyond the general factor, thus implying that they cannot be separated from overall humor potential. Consequently, any individual relationships between these comic styles and external variables are mostly accounted for by variance associated with overall humor potential.

To supplement the bifactor model, we calculated several bifactor indices. These provide important additional information about the CSM and how it should be interpreted. First, high values for the omega for both the general and specific factors indicated a high level of internal consistency. Second, the high value for omega$_H$ for the general factor indicated that total CSM scores can be interpreted as a measure of a unidimensional construct. Third, the relatively low value for ECV indicated that there was a non-negligible amount of multidimensionality in CSM scores (although still over 60% of the common variance was explained by the general factor, implying it is the dominant construct being measured by the CSM). In short, these findings demonstrate that the CSM items are multidimensional (that is, they have relationships with both the general and specific factors, requiring a model that reflects this complexity) and also that the

dominant general factor is essentially unidimensional. Because the general factor was a common source of variance for all CSM items, researchers interested in humor potential as a broad general trait would be justified in calculating and interpreting total scores for the CSM. However, we advise modeling CSM scores using the bifactor model to control for the unique effects of specific comic styles. Moreover, researchers interested in assessing the narrower comic styles can calculate individual scores but should be aware that a substantial amount of variance in any observed correlation will be due to the general construct (particularly for Irony and Benevolent humor), and thus should also consider the bifactor model.

4.2 *The hierarchical structure of the Portuguese CSM broadly replicates that of past studies*

Our second research question concerned testing the latent structure of the CSM at the scale-level using a hierarchical process. Two past studies have considered this issue using a different language version of this measure, and both concluded that a small number of second-order factors could represent the eight comic styles (Ruch 2012; Ruch et al. 2018). The present study describes the full latent hierarchical structure of the Portuguese CSM and thus offers new insights into the way humor is structurally represented. Because the first independent comic style emerged as a factor in the fourth step of the hierarchical process, and because part works have typically identified three higher-order factors, we shall only consider in depth the factors from the first three levels of the hierarchical process.

At the broadest level was a general factor that was positively related to all comic styles, and thus representative of one's overall potential for humor. Individuals scoring high on this factor tend to engage in humor more and find things more humorous, independent of style, than those who score lower on this factor. This general factor then decomposed into two components that reflected what Ruch and Heintz et al. (2018) distinguished as light and dark styles, the former of which then further decomposes into what we defined as the *affiliative style* and the *reflective style*. The darker style -- associated with cynicism, sarcasm, and to a weaker extent irony and satire -- has consistently been identified in other approaches to humor (e.g. Craik et al., 1996; Martin et al., 2003) and was consistent with the "mockery" factor extracted in the

hierarchical analysis of Ruch and Heintz et al. (2018). Based on the content of this factor, Ruch
and Heintz noted that people who use this style do so with the malicious intention of hurting
others or gaining superiority. The affiliative style was defined by its social orientation.
Specifically, it was associated with Fun, Wit, and Irony, implying a style aimed at bringing
people together by spreading goodwill, achieving social approval, and/or creating a sense of
mutual superiority. Thus, this higher-level style was conceptually similar to the affiliative
humor style defined by Martin et al., (2003) because it reflects comedic behaviors aimed at
enhancing one's social relationships (be it innocently or at the expense of others). Finally, the
third higher-level style was associated most strongly with benevolent humor, satire, and
nonsense. Both benevolent humor and satire have been linked empirically and conceptually to
virtue in that they are profound humor styles aimed at doing good (Ruch and Heintz 2016),
although all comic styles in some way can be considered virtuous (Ruch et al. 2018). All three
styles can be considered to have a focus that transcends the self: benevolent humor involves an
empathic understanding of the shortcomings of the world and humanity, satire involves an
attempt to correct moral injustices, and nonsense requires creativity to play with abstract notions
of sense and language. Thus, we tentatively labeled this style the reflective style given its
similarity to the reflective style of Craik et al. (1996). This style shared some similarities with
what Ruch and Heintz et al. (2018) identified as good humor, and what Ruch (2012) also
labeled reflective humor, although it differed in its inclusion of nonsense.

In short, this analysis showed comic styles can be represented at various levels of
abstraction. The three intermediate second-order styles highlighted (affiliative style, reflective
style, and dark style) differed slightly from those identified in past research, suggesting there
may be cultural differences in the structure of comic styles. However, the distinction between
light vs. dark styles was a clear replication of past work. Furthermore, the split of the light style
into a social and reflective style was broadly consistent with the findings of Ruch (2012).

4.3 *Comic styles are differently related to personality dimensions*

The third component of the study considered the relationship between the eight comic styles and the personality dimensions of Cloninger's psychobiological model. Testing these specific associations has the potential to advance current understanding about the personality-humor association because, unlike dimensions from taxonomic models, temperament and character dimensions correspond to distinct systems and processes that can causally explain intraindividual differences in humor. By using a bifactor approach, we were able to test the unique contributions of the general factor and specific factors in relation to personality variables. Using a bifactor approach for this is important because facets can be differently associated with criterion variables, including correlations of opposite directions, and because it is possible for a general factor to not contribute anything to this association over and above the facets (Chen et al. 2012). Aligning somewhat with this last possibility, we found that the general factor was only meaningfully associated with novelty seeking, whereas specific factors displayed several weak associations with multiple personality dimensions. This suggests that overlying variance in comic style use (that is, whether a person engages in many or few comic styles) is linked to whether a person has an automatic tendency to be excitatory, impulsive, and extravagant, but not strongly linked to other personality dimensions. Given that novelty seeking tends to display a moderate positive association with extraversion (De Fruyt, Van De Wiele & Van Heeringen 2000), this finding is consistent with studies that have shown, for example, that extraverts have a higher propensity for laughter (Ruch & Deckers 1993).

There were a small number of practically significant associations between comic styles and temperament dimensions. First, wit had a negative correlation with harm avoidance. Harm avoidance measures sensitivity to fearful stimuli and avoidance learning and is related to activation in the amygdala and insular salience network (Zwir et al. 2020a). As such, individuals scoring low in harm avoidance are typically outgoing, relaxed, and confident. As such, our finding is consistent with studies that have linked wit to extraversion (itself negatively correlated with harm avoidance; Ruch, Heintz et al., 2018). Further, while causality cannot be inferred from correlations, the results imply that people who tend to be uninhibited and unafraid

of failure are more likely to be those who make cognitive efforts to be witty. Moreover, the positive correlation between wit and persistence also suggested that the pursuit of comic brilliance through wit requires a dispositional tendency to be resistant to criticism and ambitious. A second finding was that dark styles showed a trend of negative correlations with reward dependence. Reward dependence relates to a person's tendency to maintain a behavior that was once rewarded and relates to the activity of dopaminergic neurons (Zwir et al. 2020a). Low values for reward dependence manifest as a person being cold, withdrawn, and insensitive to social cues (Cloninger 1987).

Concerning character, it was evident that Sarcasm and Cynicism shared similar negative correlations with self-directedness and cooperativeness. Self-directedness describes the ability to regulate and adapt behavior in accordance with personal goals and values, and individuals low in this trait can be described as immature, unreliable, and ineffective. Cooperativeness captures one's ability to accept and identify with other peoples, and individuals low in this trait are typically critical, revengeful, and destructive (Cloninger 2004). People with low values for these two dimensions are consistently the least healthy and most immature (Cloninger et al. 1993) and research indicates unhealthy characters are detrimental to human functioning and wellbeing (e.g. Cloninger and Zohar, 2011; Josefsson et al., 2011). Consequently, these results suggest that dark humor may be an expression of humor for those with an unhealthy character. This finding is consistent with research that has linked neuroticism (itself correlated with low self-directedness) to dark comic styles (Ruch, Wagner and Heintz 2018; Ruch et al. 2018). Finally, the analysis also showed that wit was positively related to self-transcendence. This result implies that the use of wit is linked to creativity and organizations of higher-order cognitive processes that allow the individual to transcend their self-boundaries and think at a higher level of abstraction (Cloninger et al. 1993).

In summary, this analysis showed a weak positive association between one's overall humor potential and novelty seeking temperament. This suggests that one's propensity for humor (the *quantitative* component of humor) is linked, at least partly, to temperamental

tendencies to seek excitement and thrills, to be dramatic, and to be extravagant with their energy and feelings (Cloninger, Svrakic & Przybeck 1993), and their underpinning psychobiological systems for behavioral activation (Cloninger 1987; Gardini, Cloninger & Venneri 2009). In contrast, we found that the comic style specific factors (the *qualitative* component of humor) were more variably and strongly related to Cloninger's personality dimensions. In particular, we found that dark styles were linked to unhealthy characters while wit was linked to a tendency to be outgoing and extraverted. These findings support theoretical assertions that comic styles need to be differentiated, offer preliminary insights into what types of people tend to use and appreciate different comic styles, and contribute to understanding the psychobiological processes and systems that underlie these differences.

4.4 *Study Limitations*

A first limitation of the study was that the sample was recruited using a non-random sampling procedure. While the moderately large size of the resulting sample can be considered a study strength, it is important to acknowledge that this form of sampling limits finding generalizability, and therefore represents a threat to external validity. Consequently, future studies should seek to replicate our findings with more diverse Portuguese samples. It is also important to acknowledge that the study only used self-report measures. This methodological decision can be criticized for its potential for introducing biases (e.g. participants may wish to present themselves favorably rather than honestly). However, researchers have challenged the prevalent belief that these issues pose a severe threat to study validity (Chan 2009). Finally, it is worth acknowledging that we did not test whether the mode of data collection (supervised in class vs. unsupervised at home, alone) influenced the results.

4.5 *Conclusions*

Accurate and psychometrically adequate assessments of comic styles, both broad and narrow, are vital for researchers and practitioners interested in the interplay between humor and mental health. The current study considered three research questions to evaluate the overall validity of

the CSM when applied to a sample of Portuguese adults. Our main overall finding was that the

CSM appeared to measure what it claims to measure. More specifically, we found (a) the CSM

could be modelled using a bifactor model that included eight specific factors (representing

narrow comic styles) and a general humor factor, (b) humor could be represented at several

levels of abstraction increasing from eight comic styles to one broad humor factor, and (c) the

eight comic styles were differentially related to psychobiological personality traits.

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0579-x.

A. Correlated factors model
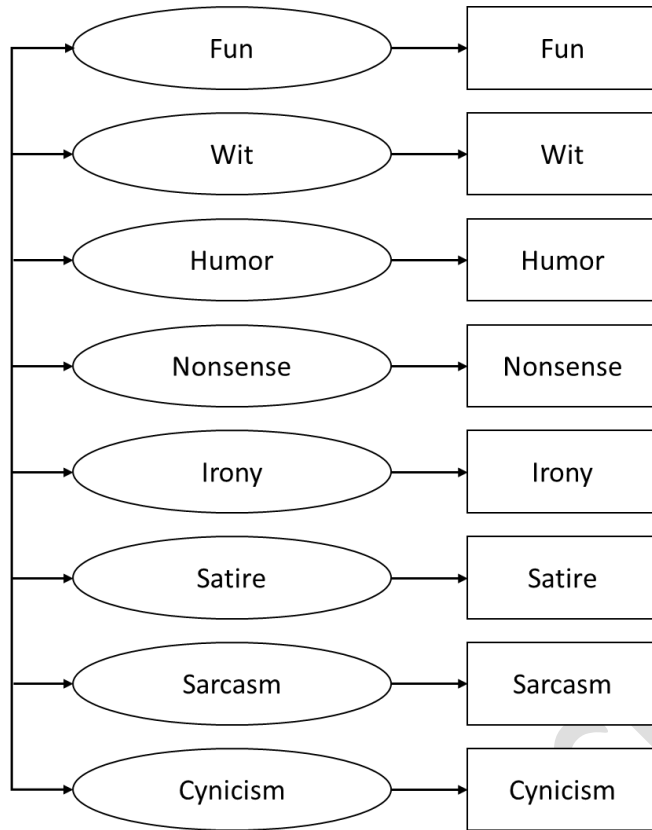
B. Second-order model
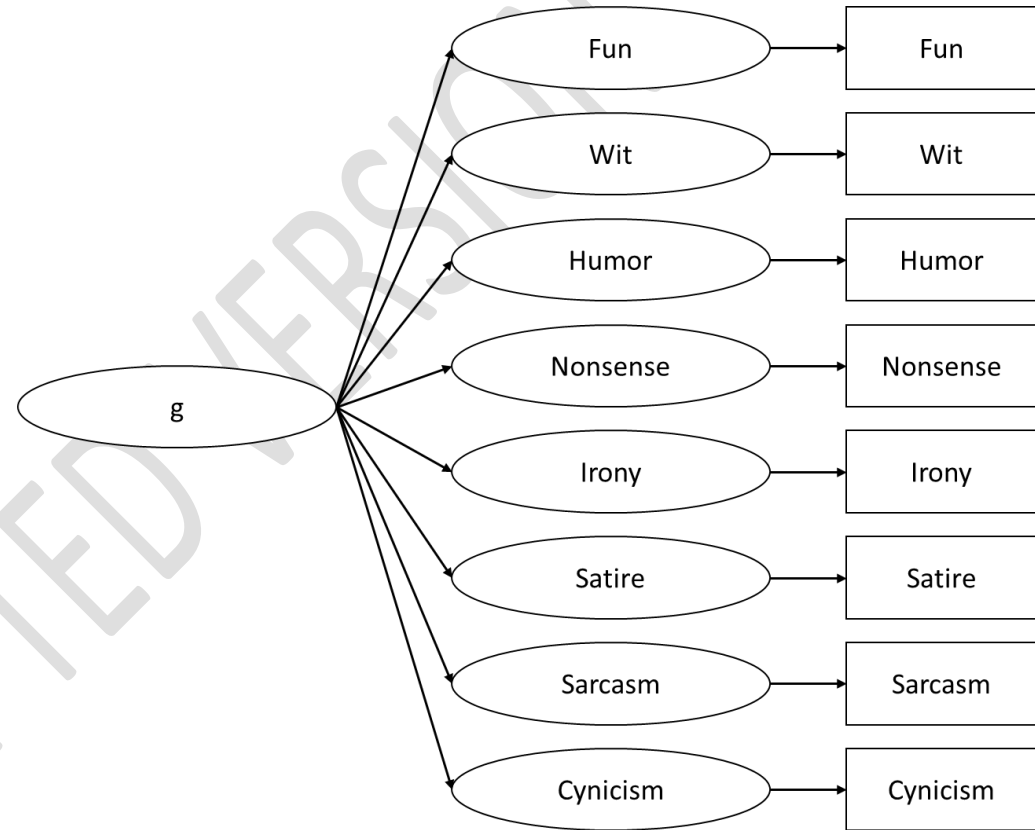
Figure 1. Graphical representations of the three types of model tested. (A) Correlated factors model. (B) Second-order model. (C) Bifactor model. Manifest variables (rectangles) represents sets of multiple items. g = general humor factor. S1 – S8 = specific factors.

C. Bifactor model
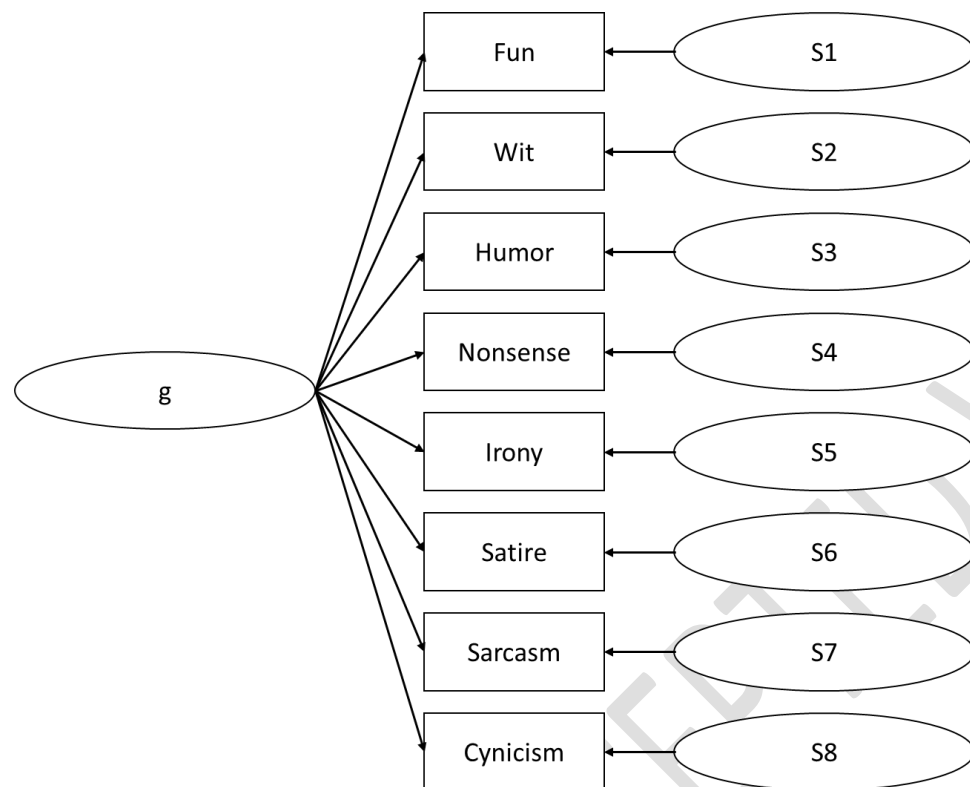
Figure 1. Continued.
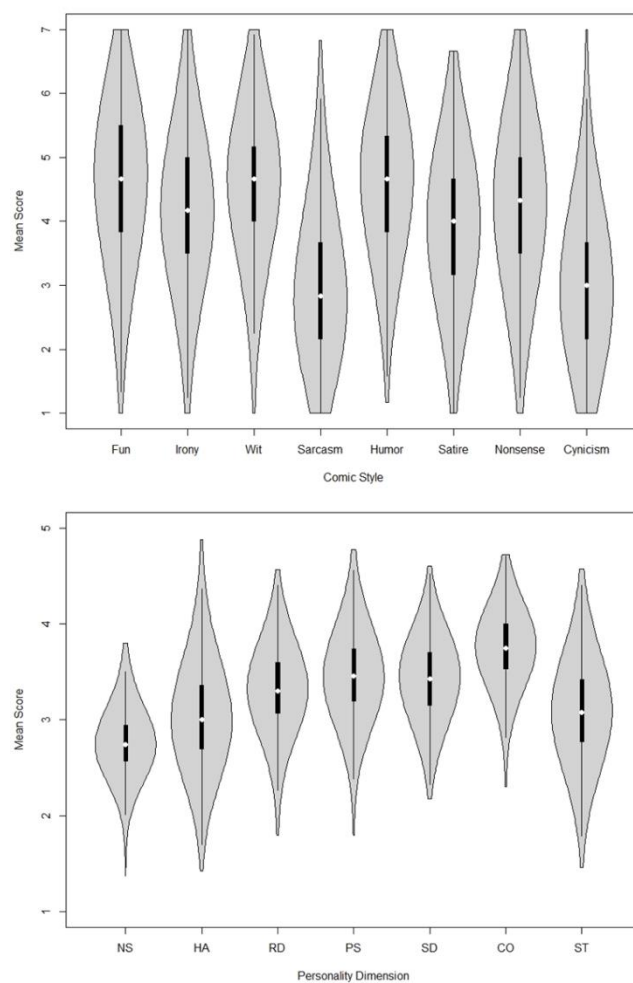
Figure 2. Univariate distributions (violin plot) of scores for the eight comic styles (upper panel) and seven personality dimensions (lower panel). Each distribution plot contains a box plot with scale median and interquartile range.
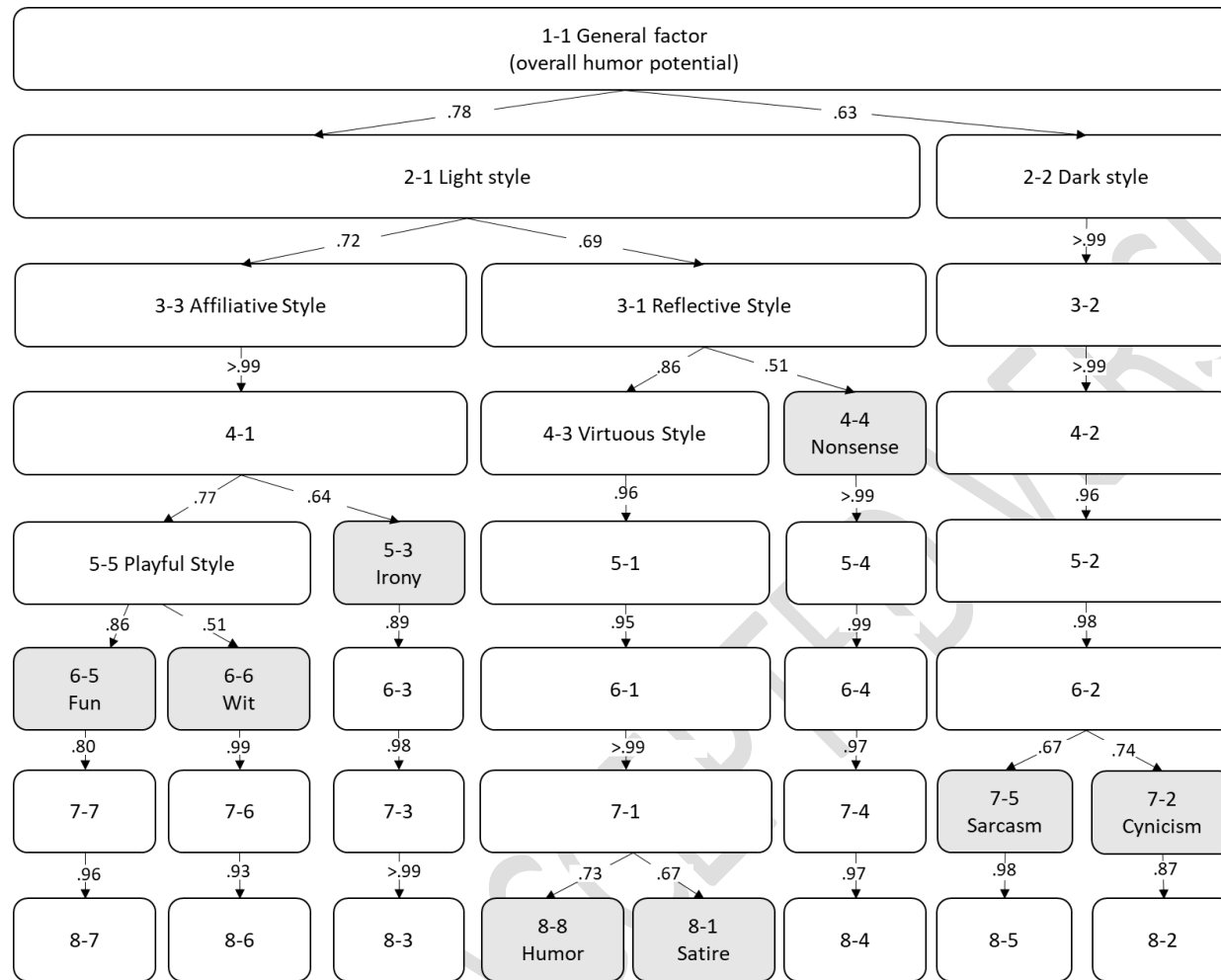
Figure 3. Hierarchical structure across principal components analyses for the CSM. Values associated with arrows are Pearson correlations between component scores. Only the largest path to each new component was presented. Numbers before labels (e.g. 2-1) indicate placement in the solution. Labels are only presented the first time the component occurs. Components highlighted in grey correspond to distinct comic styles.

Table 1.

Model fit indices for the CFA.

	X^2	*df*	Robust CFI	Robust RMSEA	SRMR
Model 1: Correlated eight-factor model[a]	3485.1[***]	1052	.778	.059	.075
Model 2: Second-order model	4047.9[***]	1072	.729	.065	.086
Model 3: Bifactor model	3665.6[***]	1032	.760	.062	.080

Note. [a]Model inadmissible because covariance matrix of latent variables was not positive definite. [***] X^2 test significant at p < .001.

Table 2

Fully standardized factor loadings and unstandardized error terms for the CSM items based on the bifactor model.

	General Factor	Specific Factors								Error
Item	λ_{GEN}	λ_F	λ_I	λ_W	λ_{Sar}	λ_H	λ_{Sat}	λ_N	λ_C	Variance
1	.49	.39								.60
9	.58	.01[a]								.66
17	.52	.23								.68
25	.56	.81								.03
33	.66	.11								.55
41	.61	.36								.50
2	.47		.07[a]							.78
10	.51		.22[a]							.69
18	.52		.52[a]							.46
26	.32		.54[a]							.60
34	.55		.25[a]							.63
42	.64		.25[a]							.54
3	.54			.41						.54
11	.56			.38						.54
19	.55			.39						.55
27	.59			.24						.60
35	.47			.29						.69
43	.68			.19						.50
4	.48				.39					.62
12	.53				.35					.59
20	.41				.41					.67
28	.26				.61					.56
36	.37				.17					.83
44	.41				.58					.50
5	.51					.09[a]				.73
13	.66					.01[a]				.57
21	.48					.48[a]				.54
29	.44					.47[a]				.59
37	.52					.38[a]				.59
45	.47					.29[a]				.69
6	.38						.43			.67
14	.58						.28			.58
22	.50						.45			.55
30	.60						*.10*[a]			.63
38	.54						.38			.56
46	.58						.21			.62
7	.35							.45		.67
15	.55							.39		.55
23	.46							.47		.56
31	.52							.21		.68
39	.57							.47		.45
47	.59							.26		.58
8	.36								.33	.76
16	.35								.55	.58
24	.43								.52	.55

Item	λ_{GEN}	λ_F	λ_I	λ_W	λ_{SAR}	λ_H	λ_{SAT}	λ_N	λ_C
32	.47							.44	.59
40	.38							.53	.57
48	.26							.58	.60
Variance	.41	.26	.01[a]	.31	.44	.02[a]	.51	.76	.29
Omega/Omega$_S$	.96	.84	.77	.82	.73	.77	.79	.80	.78
Omega$_H$/Omega$_{HS}$	.90	.20	.21	.20	.40	.17	.20	.29	.50
ECV	.63								
PUC	.89								

Note. λ_{GEN} = factor loadings on the General Factor. λ_F = factor loadings on the Fun specific factor. λ_I = factor loadings on the Irony specific factor. λ_W = factor loadings on the Wit specific factor. λ_{SAR} = factor loadings on the Sarcasm specific factor. λ_H = factor loadings on the Humor specific factor. λ_{SAT} = factor loadings on the Satire specific factor. λ_N = factor loadings on the Nonsense specific factor. λ_C = factor loadings on the Cynicism specific factor. [a] = non-significant factor loading/variance. ECV = Explained Common Variance. Larger ECVs provide more confidence in applying a unidimensional measurement model to multidimensional data. PUC = Percentage of Uncontaminated Correlations. The combination of ECV > .70 and PUC > .70 indicates common variance is essentially unidimensional.

Table 3

Loadings for the series of principal component analyses, from one to eight components, conducted to test the hierarchical structure of comic styles. Components are ordered from most to least proportion variance explained

Comic Style	1	2		3			4				5					6					
	1-1	2-1	2-2	3-2	3-3	3-1	4-2	4-1	4-3	4-4	5-2	5-1	5-5	5-3	5-4	6-2	6-1	6-6	6-4	6-3	6-5
Fun	**.79**	**.85**	.21		**.76**	**.46**		**.76**	.35	.31		.27	**.81**	.21	.30		.29	**.40**	.31	.27	**.70**
Irony	**.79**	**.57**	**.56**	**.51**	**.74**		**.50**	**.74**		.22	.36		.31	**.80**	.21	.33		.27		**.84**	
Wit	**.79**	**.84**	.22		**.79**	**.41**		**.79**	**.43**			**.46**	**.62**	**.48**			.30	**.84**		.26	.22
Sarcasm	**.73**	.26	**.85**	**.82**	.30		**.83**	.30			**.88**		.35			**.85**					.37
Benevolent	**.76**	**.84**			.38	**.83**		.39	**.82**	.25		**.81**	.38		.25		**.77**	**.41**	.27		.21
Satire	**.82**	**.56**	**.61**	**.54**		**.69**	**.56**		**.69**		**.51**	**.73**				**.47**	**.77**			.22	
Nonsense	**.75**	**.65**	.38	.31	.30	**.68**	.25	.29	.28	**.87**	.22	.28	.26		**.87**	.22	.27		**.88**		
Cynicism	**.68**		**.92**	**.90**		.21	**.89**			.24	**.83**			.30	.25	**.86**				.26	.22
% Variance	.59	.41	.31	.27	.26	.26	.27	.26	.20	.13	.24	.20	.19	.14	.13	.24	.19	.15	.14	.12	.10

Comic Style	7							8							
	7-1	7-2	7-4	7-6	7-3	7-5	7-7	8-2	8-4	8-8	8-5	8-3	8-7	8-6	8-1
Fun	.26		.27	.34	.23		**.80**		.24	.25		.23	**.83**	.29	
Irony		.24		.25	**.85**	.21	.21	.23			.22	**.85**	.22	.24	
Wit	.29			**.82**	.26		.31			.28		.26	.30	**.83**	
Sarcasm		.39			.21	**.84**		.34			**.86**	.20			
Benevolent	**.78**		.32	**.40**					.23	**.86**			.23	.25	.25
Satire	**.74**	**.51**					.26	.28	.21	.30	.24			**.80**	
Nonsense	.25	.22	**.87**				.22		**.89**	.22			.21		
Cynicism		**.86**	.20			.33		**.88**			.31				.21
% Variance	.18	.16	.13	.13.	13.	12	.12	.13	.13	.13	.13	.12	.12	.12	.11

Note. Loadings > |.40| are highlighted in bold. For clarity, loadings < |.20| have been omitted.

Table 4.

Factor correlations between the CSM factors from the bifactor model and external variables.

| | | Specific Factors | | | | | | | |
| | | Lighter styles | | | | | Darker styles | | |
	General factor	Fun	Wit	Humor	Nonsense	Irony	Satire	Sarcasm	Cynicism
Temperament									
Novelty seeking	**.31***	.01	-.03	-.12	-.05	-.21	-.11	.15	.01
Harm avoidance	-.06	.08	**-.37***	-.19	.03	.09	-.17*	-.00	-.03
Reward dependence	.11	.12	.02	.05	-.05	-.14	-.17*	**-.28***	-.14
Persistence	.14*	-.02	**.44***	.25	-.01	.16	-.01	-.04	-.06
Character									
Self-directedness	-.18*	-.07	.18*	.10	-.14*	-.13	.03	**-.24***	**-.22***
Cooperativeness	.01	-.04	-.10	.14	-.06	-.13	**-.24***	**-.52***	**-.43***
Self-transcendence	.16*	.03	**.26***	.29	.04	.25	.00	.07	-.07

Note. Correlations > |.20| are highlighted in bold. * *p* < .05