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# Measuring the subjective: revisiting the psychometric properties of three rating scales that assess the acute effects of hallucinogens

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**Objective** In the present study we explored the psychometric properties of three widely used questionnaires to assess the subjective effects of hallucinogens: the Hallucinogen Rating Scale (HRS), the Mystical Experience Questionnaire (MEQ), and the Addiction Research Center Inventory (ARCI).
**Methods** These three questionnaires were administered to a sample of 158 subjects (100 men) after taking ayahuasca, a hallucinogen whose main active component is *N,N*-dimethyltryptamine (DMT). A confirmatory factorial study was conducted to check the adjustment of previous data obtained via theoretical proposals. When this was not possible, we used an exploratory factor analysis without restrictions, based on tetrachoric and polychoric matrices and correlations.
**Results** Our results sparsely match the theoretical proposals of the authors, perhaps because previous studies have not always employed psychometric methods appropriate to the data obtained. However, these data should be considered preliminary, pending larger samples to confirm or reject the proposed structures obtained.
**Conclusions** It is crucial that instruments of sufficiently precise measurement are utilized to make sense of the information obtained in the study of the subjective effects of psychedelic drugs. Copyright © 2016 John Wiley & Sons, Ltd.

KEY WORDS—psychedelics; ayahuasca; Hallucinogen Rating Scale (HRS); Addiction Research Center Inventory (ARCI); Mystical Experience Questionnaire (MEQ); psychometrics

## INTRODUCTION

Of all psychoactive drugs, hallucinogens or psychedelics may be the substances that induce the most dramatic and profound changes in the state of consciousness. However the subjective effects they impart are perhaps the most difficult aspect of their impact to measure. Classic hallucinogens or psychedelics such as Lysergic acid Diethylamide (LSD), mescaline, psilocybin, or DMT (*N,N*-Dimethyltryptamine), the active principle of the Amazonian decoction known as ayahuasca (Nichols, 2004) acts as partial agonists of 5-HT2A brain receptors (Vollenweider *et al.,* 1998; Kometer *et al.,* 2013). Acute effects of classical hallucinogens induce cortical blood flow activation in frontal and paralymbic areas of the brain (Vollenweider *et al.,* 1997; Hermle *et al.,* 1998; Riba *et al.,* 2006; de Araujo *et al.,* 2012) as well as decrease in the metabolic activity of the default mode network (DMN) (Carhart-Harris *et al.,* 2012; Palhano-Fontes *et al.,* 2015).

Throughout the last two decades, hallucinogenic drug research has attracted the interest of scientists in such a way that some researchers have talked about a "Psychedelic Renaissance" (Sessa, 2012; Tupper and Labate, 2014). Nowadays there exist multiple lines of research with several hallucinogenic or psychedelic drugs, including the characterization of pharmacological properties (e.g. dos Santos *et al.,* 2012; Schmid *et al.,* 2014), neurobiological substrates (e.g. Kraehenmann *et al.,* 2014; Tagliazucchi *et al.,* 2014), mystical mimetic potential and its eventual associated benefits (e.g. Griffiths *et al.,* 2006; Garcia-Romeu *et al.,* 2014), and psychotherapeutic potentialities (e.g. Grob *et al.,* 2011; Mithoefer *et al.,* 2011; Oehen *et al.,* 2013; Thomas *et al.,* 2013; Gasser *et al.,* 2014; Fernández *et al.,* 2015).

Most contemporary psychedelic research employs different rating scales to assess the subjective effects of research subjects and/or patients. However, while pharmacological and neurobiological techniques

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havegained sophistication over time, fewer efforts have been made to improve the psychometric properties of the different rating scales. Most contemporary psychedelic research in which subjective effects are measured have used one or more of the following rating scales: Abnormal Mental States questionnaire (APZ; Dittrich, 1975; Dittrich, 1998) and its revised versions, OAV (Bodmer *et al.,* 1994) and 5D-ASC (Dittrich *et al.,* 2006; Dittrich *et al.,* 2010); Addiction Research Center Inventory (ARCI; Haertzen, 1966; Martin *et al.,* 1971), Hallucinogen Rating Scale (HRS; Strassman *et al.,* 1994), and different previous versions of the Mystical Experience Questionnaire (MEQ; Pahnke, 1963; Pahnke, 1969). Among these rating scales, OAV (Studerus *et al.,* 2010), and MEQ (MacLean *et al.,* 2012; Barrett *et al.,* 2015) are the only questionnaires that have been subjected to rigorous psychometric analysis in order to confirm the theoretical structure originally proposed by their authors. But to our knowledge, MEQ is only validated in English for the effects of psilocybin, and OAV in German. The ARCI and HRS factorial structure, as well as their internal consistencies (reliability), have been poorly analyzed with statistical methods that have already been surpassed, and, to our knowledge, only in Spanish (Lamas *et al.,* 1994a; Riba *et al.,* 2001). Consequently, the interpretation of the results based on these methods has many limitations. Regarding the MEQ, although the factorial structure and reliability of the original proposed model have been recently analyzed (MacLean *et al.,* 2012; Barrett *et al.,* 2015), further research is necessary in order to confirm its empirical structure in different cultural samples and with other substances.

The MEQ (MacLean *et al.,* 2012; Barrett *et al.,* 2015) is a modified version of the State of Consciousness Questionnaire—SCQ (Griffiths *et al.,* 2006, 2008, 2011), a psychological rating scale originally constructed by Pahnke (Pahnke, 1963, 1969) to assess the spiritual peak effects of hallucinogens. Different versions of this questionnaire were used extensively, under different names such as "Post-Drug Questionnaire" or "Psychedelic Experience Questionnaire", in old psychedelic research to measure the mystical mimetic effects of psilocybin, dipropyltryptamine (DPT) and other hallucinogenic drugs (Pahnke, 1963; Turek *et al.,* 1974; Richards *et al.,* 1977; Doblin, 1991). The most common version of this scale (named SCQ) used in modern psychedelic research has 100 items, only 43 of them corresponding to its 6 subscales, namely: Internal and external unity (pure awareness; a merging with ultimate reality; unity of all things; all things are alive; all is one); Transcendence of time and space; Ineffability and paradoxicality (claim of difficulty in describing the experience in words); Sense of sacredness (awe); Noetic quality (claim of intuitive knowledge of ultimate reality); and Deeply felt positive mood (joy, peace, and love). The remaining 57 are distracter items, which assess different phenomenological contents of the psychedelic experience (Griffiths *et al.,* 2006). The SCQ questionnaire was constructed according to a theoretical model of the spiritual experience (Stace, 1960) based on six possible dimensions, in which items were grouped in a way that they could be clustered within any of these six dimensions. The SCQ has been utilized in a series of studies exploring the mysticomimetic properties of psilocybin (Griffiths *et al.,* 2006, 2008, 2011), and ayahuasca (Trichter *et al.,* 2009); the pharmacological properties of DMT (Riba *et al.,* 2014) and dextromethorphan (Reissig *et al.,* 2012); and the psychotherapeutic potential of psilocybin (Johnson *et al.,* 2014; Bogenschutz *et al.,* 2016) and LSD (Gasser *et al.,* 2014). MacLean *et al.* (2012) and Barrett *et al.* (2015) have recently explored the validity, reliability and factor structure of SCQ. MacLean *et al.* (2012) performed an exploratory factorial analysis (EFA) on a sample of 1602 subjects who confirmed that at some point in their lives they had taken an active dose of psilocybin mushrooms that produced moderate to strong psychoactive effects. The authors found a four-factor solution that named: Mystic (composed by the former dimensions Internal and external unity, Noetic quality, and Sacredness), Positive mood, Transcendence of time and space, and Ineffability. The questionnaire was composed of 30 final items explaining 57% of the variance. The authors also found excellent alpha reliability for the whole scale ($\alpha = 0.933$) and good internal consistency for the four provisional subscales ($\alpha = 0.926$; 0.831; 0.810; 0.800, respectively). In a second study, the authors performed a confirmatory factorial analysis on 440 subjects where the four-factor structure was confirmed, explaining 64% of the variance for each item, and replicating the internal consistence found in the precedent study. Authors renamed the final 30 items of the SCQ questionnaire as MEQ. In a subsequent study, Barrett *et al.* (2015) confirmed the factorial structure of the MEQ in a series of clinical studies using psilocybin with subsamples of $n = 36$, 18, 15, 71, and 51 subjects.

The HRS (Strassman *et al.,* 1994) was created for use in a series of clinical trials intended to study the pharmacological properties of the hallucinogen DMT (Strassman and Qualls, 1994; Strassman, 1996; Strassman *et al.,* 1996). Nineteen hallucinogen users



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with experience of DMT gave a thorough description of the effects of smoked DMT freebase that was operatized into 126 individual items. The authors utilized two methods destined to gather the items. First, they defined six conceptually coherent clusters where different items were placed: Somaesthesia (interoceptive, visceral, and cutaneous/tactile effects); Affect (emotional/affective responses); Perception (visual, auditory, gustatory, and olfactory experiences); Cognition (alterations in thought processes or content); Volition (a change in capacity to willfully interact with themselves, the environment, or certain aspects of the experience); and Intensity (strength of the various aspects of the experience). In addition, they performed a principal components factor analysis after administering four different doses of DMT and one of placebo to 11 subjects, obtaining six factors, corresponding to the number of clinical clusters (Strassman *et al.,* 1994). Authors did not report either data regarding the items load for each factor, nor indices of internal consistence, although the factor loadings are available under request (Strassman *et al.,* 1994), showing that they do not fit into their intended factors. Riba *et al.* (2001) translated the version 3.06 (composed by 99 items, although only 71 of them were computable) of HRS to Spanish, administering it to a sample of 127 Spanish subjects in two different studies. In study one, 71 subjects answered the questionnaire 4 h after an ayahuasca experience, and in study two, 56 experienced hallucinogen users performed the questionnaire retrospectively in simulated conditions. Because of the limited sample size, the authors could not explore the factor structure of the scale. Nevertheless, they were able to perform a principal components analysis with the scores of both samples for each of the 6 subscales, finding a two factors solution: Factor 1 was composed by Somaesthesia, Perception, Cognition, Affect and Intensity; and Factor 2 was composed by Volition. The explained variance for each study was 75% and 68%, respectively. They also performed reliability analysis of each dimension for each study sample, finding Cronbach's acceptable alpha indices for Affect, Cognition, Perception and Somaesthesia, but inadequate indices for Volition ($\alpha = 0.51$–$0.54$) and Intensity ($\alpha = 0.33$–$0.50$). The HRS has been extensively used in hallucinogen research after the administration of psilocybin (Griffiths *et al.,* 2006; Griffiths *et al.,* 2011), DMT (Gouzoulis-Mayfrank *et al.,* 2005; Riba *et al.,* 2014), ketamine (Bowdle *et al.,* 1998; Gouzoulis-Mayfrank *et al.,* 2005), *Salvia divinorum* (González *et al.,* 2006; Johnson *et al.,* 2011; Addy, 2012; MacLean *et al.,* 2013), 2C-B (2,5-dimethoxy-4-bromophenethylamine) (Caudevilla-Gálligo *et al.,* 2012), MDE (3,4-methylenedioxy-N-ethyl-amphetamine) (Gouzoulis-Mayfrank *et al.,* 1999), MDMA (3,4-methylenedioxy-methamphetamine) (Tancer and Johanson, 2001; Tancer and Johanson, 2003; Johanson *et al.,* 2006; Caudevilla-Gálligo *et al.,* 2012), and ayahuasca (e.g. Riba *et al.,* 2003; dos Santos *et al.,* 2011, 2012), and in psychotherapeutic studies with psilocybin (Moreno *et al.,* 2006; Bogenschutz *et al.,* 2016) and MDMA (Bouso *et al.,* 2008).

The ARCI is a 600-item questionnaire developed for the assessment of subjective effects and abuse potential of psychoactive drugs. Items were empirically derived based on the verbal reports of the subjects after the administration of different types of drugs. Afterwards, authors performed a factorial analysis obtaining the so-called group variability scales (Haertzen, 1966). Martin *et al.* (1971) selected some of the group variability scales to configure a shorter version of the scale composed by 49 items. This shorter version of the ARCI is one of the most widely used rating scales for assessing the abuse potential and subjective effects of psychoactive drugs, and has proved sensitive to the effects of an extensive number of drugs belonging to different pharmacological families of drugs of abuse, such as cocaine (Lundahl and Lukas, 2007), GHB ($\gamma$-Hydroxybutyric acid) (e.g. Abanades *et al.,* 2006), benzodiacepines (e.g. Lintzeris *et al.,* 2007), opiates (e.g. Lamas *et al.,* 1994b), piperazines (e.g. Jan *et al.,* 2010) and amphetamines (e.g. Lane *et al.,* 2014), among others. ARCI consists of five dimensions: MBG (morphine-benzedrine group, a measure of euphoria); PCAG (pentobarbital-chlorpromazine-alcohol group, a measure of sedation); LSD (lysergic acid diethylamide scale, a measure of dysphoric and psychotomimetic changes); BG (Benzedrine group, a stimulant-sensitive scales); and A scale (amphetamine, an empirically-derived scale sensitive to the effects of *d*-amphetamine). For each subscale of the 49-item ARCI, certain items from the original version were selected; therefore the final number of items is different for each subscale. The items selected for the shorter version were not the result of a psychometric analysis; thus the load of each item for each given subscale is unknown, as well as the percentages of the explained variance (Martin *et al.,* 1971). Lamas *et al.* (1994a) developed a Spanish version of the ARCI after translating and applying it into a Spanish sample of 45 opiate addicts in detoxification programs in retrospective simulated conditions while they remembered the effects of morphine-like opioids (heroin), alcohol, psychostimulants (cocaine), and hallucinogens (LSD). Good reliability indices were obtained for



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PCAG (α = 0.87), MBG (α = 0.81), and BG (α = 0.79), but those for A (α = 0.49) and LSD (α = 0.55) were inadequate. The reliability indices are higher than those obtained by Haertzen (1974) for the original version of the ARCI, but because the number of items composing each subscale is different in each version, it is not possible to establish direct comparisons. Because Lamas *et al.* (1994a) wanted to preserve the original scales of ARCI, they did not perform a factorial analysis in order to explore the factor structure of the questionnaire. Instead of this, they developed a discriminant analysis in order to check its feasibility, finding that PCAG, MBG, LSD, and BG subscales significantly discriminated among conditions, which was not the case of the A subscale. A subsequent study by this same research group with the ARCI Spanish 49-item version found sensitivity to different effects of several types of drugs (different benzodiazepines, cocaine, alcohol, morphine, etc.) in a series of clinical trials (Arasteh *et al.,* 1999). To our knowledge, the factorial structure of this ARCI short version never has been studied. The 49-item version has been applied extensively in psychedelic research after the administration of psilocybin (e.g. Griffiths *et al.,* 2006, 2011; Bogenschutz *et al.,* 2016), MDMA (e.g. Cami *et al.,* 2000; Kuypers *et al.,* 2006), ketamine (e.g. Shram *et al.,* 2011), *S. divinorum* (e.g. MacLean *et al.,* 2013), THC (delta-9-tetrahydrocannabinol) (e.g. Ballard *et al.,* 2012), and ayahuasca (e.g. Riba *et al.,* 2003; dos Santos *et al.,* 2011, 2012).

In sum, psychometric questionnaires to assess subjective effects of hallucinogens have numerous limitations that make the interpretation of results difficult. In this study we present novel psychometric data for the MEQ, HRS, and ARCI questionnaires, and propose preliminary new versions and/or alternative interpretations of the data for each of them. The questionnaires were administered to a sample of subjects after their participation in ayahuasca ceremonies. Ayahuasca is a decoction, originally used by Amazonian communities, composed of at least two plants (generally *Psychotria viridis* and *Banisteriopsis caapi*) containing the hallucinogen DMT and the beta-carboline compounds harmine, harmaline, and tetrahydroharmine (Schultes and Hofmann, 1972). Because of the recent widespread use of ayahuasca in Western countries, including Spain, it is possible to have access to a significant sample of ayahuasca users, and therefore to incorporate ayahuasca into the set of substances being examined as part of a range of studies that may allow relevant conclusions about the usefulness of these methodological tools to be made.

## METHODS

### *Participants*

Researchers contacted ayahuasca practitioners in different parts of Spain, who provided information about when the ceremonies were taking place. Once present, at the end of each session, researchers asked the participants if they were willing to participate in the study. After giving their informed consent, subjects completed a booklet containing sociodemographic questions, and the Spanish versions of ARCI, HRS, and MEQ. All the ceremonies were carried out by a Spanish practitioner for the purpose of personal growth, while excluding religious purposes.

All the subjects had signed an informed consent form prior to participation. The Research Ethical Committee of the Autonomous University of Madrid (Spain) approved all the study procedures.

### *Instruments*

*Sociodemographic questionnaire.* This section included questions on age, sex, civil status, place of birth, place of residence, education level, previous experience with psychedelics, ayahuasca dose ingested in the ceremony, and subjective effect attained (low, medium, high).

*MEQ (Maclean et al.,* 2012). The MEQ is a self-report questionnaire designed to measure single mystical experiences that result from ingesting hallucinogens. It consists of 30 items rated on a six-point scale [0 = none, not at all; 1 = so slight, cannot decide; 2 = slight; 3 = moderate; 4 = strong (equivalent in degree to any previous strong experience or expectation of this description); and 5 = extreme (more than ever before in my life and stronger than 4)]. The MEQ has four dimensions: Mystical, Positive mood, Transcendence of time and space, and Ineffability. Data on each scale were expressed as a proportion of the maximum possible score. As far as we know, there is only one report where the 30-item MEQ questionnaire has been used in empirical psychedelic research (Barrett *et al.,* 2015). For the aims of this study, we translated MEQ into Spanish according to the principles of back translation, and placing the emphasis on conceptual rather than linguistic equivalence (Douglas and Craig, 2007). Specifically, one bilingual Spanish native Clinical Psychologist translated the English version into Spanish. Then, an English native bilingual Clinical Psychologist translated the Spanish version into English. Then, another native Spanish Clinical Psychologist translated that version into Spanish. A fourth Spanish native Clinical Psychologist with



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personal experience in the use of ayahuasca, psilocybin, and other hallucinogens resolved the discrepancies in the different translations processes placing the emphasis on conceptual, clinical and spiritual concepts rather than linguistic equivalence. The items of our version of the MEQ are shown in the Appendix.

*HRS (Strassman et al.,* 1994). The HRS is a self-report questionnaire that assesses six dimensions of the psychedelic experience: Somaesthesia, Affect, Perception, Cognition, Volition, and Intensity. In this study we used the Spanish version adapted by Riba *et al.* (2001) in which 71 Likert-type items scoring from 0 to 4 informed the different subscales and the remaining 28 questions offered qualitative information.

*ARCI (Martin et al.,* 1971). The ARCI short version is a self-report questionnaire consisting of 49 true/false items that contains five group variability scales: MBG (morphine-benzedrine group; PCAG (pentobarbital-chlorpromazine-alcohol group); LSD (Lysergic acid Diethylamide scale; BG (Benzedrine group); and A scale (amphetamine). The range of scores is 0–16 for MBG, 4 to 11 for PCAG, 4 to 10 for LSD, 4 to 9 for BG, and 0–11 for A. In this study we utilized the Spanish version adapted by Lamas *et al.* (1994a).

### *Data analysis*

To start with, we performed a confirmatory factorial analysis based on the proposals previously published for each questionnaire. We used the AMOS 18 software, performing the method of the Unweighted Least Squares when the multivariate normality could not be guaranteed while reporting the goodness of fit indicators provided by the software. The empirical identifiably of the theoretical models was studied using the criteria of McDonald and Krane (1977). These criteria are provided by the software, and although some inherent limitations are usually noted with this method (Bentler and Weeks, 1980; McDonald, 1982), it that should not affect the models studied (Rigdon, 1995). Because some of the characteristics of study variables were previously unclear, the Unweighted Least Squares method was used. When the theoretical structure could not be empirically replicated, we performed an Unrestricted Exploratory Factor Analysis, configuring firstly the polychoric (for the type-Likert questionnaires) or tetrachoric (when the answer option was dichotomic) matrices. In order to test multivariate normality Mardia criterion (Mardia, 1970) was used. After checking the suitability criteria to find out the number of factors to retain, we then performed an optimized parallel analysis based on minimum rank factor analysis (Timmerman and Lorenzo-Seva, 2011). Then, an overall factor analysis was performed, fitting the solution to the number of factors obtained by the parallel analysis. A Simplimax rotation (Kiers, 1994) was undertaken (using a Clever start with Promin, number of random starts = 100, maximum number of iterations = 100; convergence value $p < 0.00001$) and several criteria were used to guarantee the simplicity of the studied solution (Lorenzo-Seva, 2003). For the study of the residues, Kelley criterion was applied (Kelley, 1935). Aiming to analyze the internal consistency of each scale we utilized the standardized Cronbach's alpha, Carmine's theta, and McDonalds' Omega, as it is recommended for non-linear data (Javali *et al.,* 2011). For estimating the internal consistency of each subscale we used a multivariate measure, the formula of Mislevy and Bock (1990), and the standardized Cronbach's alpha as a univariate measure. The Schmid and Leiman (1957) solution was applied for studying the possible existence of superior order factors. All the mentioned analyses were performed using the program FACTOR 9.2 (Lorenzo-Seva and Ferrando, 2006; Lorenzo-Seva and Ferrando, 2013) (freely available at: http://psico.fcep.urv.es/utilitats/factor/Documentation.html).

Pearson correlations were analyzed between the scores of the factorial derived scales. Bonferroni correction was applied to avoid type I errors.

## RESULTS

### *Sample*

The questionnaires were completed in the 4 h after the end of the ayahuasca ceremony and before leaving the facilities where it took place. A total of 167 subjects answered the questionnaires, of which 158 (100 men) were usable (there were nine incomplete booklets that were dismissed from the analysis). The mean for age was 39 years old (range 20–60) and the mean educational level was equivalent to three years of University studies. A total of 134 (84%) subjects of the sample had previous experience with psychedelics (mean of 21 times with a range from 0 to 350). The mean dose received was of 113 ml of ayahuasca (range: 50–265). The DMT and beta-carboline alkaloid concentrations were unknown. The mean intensity of the perceived dose was a medium dose: 19 (12%) subjects referred received a low dose, 120 (76%) a medium dose, and 19 (12%) a high dose.



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*MEQ*

In the first place, we carried out a confirmatory factorial analysis of the tetrafactorial solution proposed by MacLean *et al.* (2012) on the data obtained. The results indicated that this model was unable to identify within our sample. Therefore, we proceeded to perform an exploratory analysis to determine the most appropriate model structure for our data. The descriptives of MEQ items are shown in Table 1.

The results obtained after the Mardia's analysis showed that the data did not comply with multivariate normality ($p < .001$). Then we configured a polychoric correlation matrix on which it was possible to perform a factor analysis (Bartlett's statistic = 2976.0; df = 435, $p < 0.0001$; KMO = 0.91). First, an optimized parallel analysis on a minimum ranges factor analysis was undertaken, which provided a solution of two factors as the better distribution of the data (Table 2).

Second, we carried out an overall factor analysis on that bifactorial solution, which explained 59.11% of the common variance (Factor 1: Eigenvalue = 11.3; % variance explained = 47.75%; Factor 2: Eigenvalue = 2.7; % variance explained = 11.37%). The estimated reliability for the two factors was of 0.95 and 0.92, respectively, and of 0.94 ($\theta = 0.94$; $\omega = 0.94$; standardized Cronbach $\alpha_s = 0.94$; inter-factor correlation = 0.61) for the whole test. That solution generated few residues, according to Kelley's criteria (RMSR = 0.062; expected mean value of RMSR for an acceptable model = 0.080), and showed excellent indices of simplicity (Bentler = 0.96; percentile = 83; loading simplicity index LSI = 0.52; percentile 100). Table 3 shows the factorial loads obtained along with the factor to which theoretically they would belong according to the model of MacLean *et al.* (2012).

Table 1. Descriptives of the MEQ items

| Item | Mean | Confidence interval 95% | Variance | Skewness | Kurtosis (zero centered) |
|---|---|---|---|---|---|
| 1 | 3.12 | (2.87 3.37) | 1.45 | −0.48 | −0.31 |
| 2 | 2.58 | (2.27 2.88) | 2.26 | −0.42 | −0.87 |
| 3 | 3.17 | (2.90 3.45) | 1.81 | −0.75 | 0.04 |
| 4 | 3.44 | (3.18 3.70) | 1.63 | −0.99 | 0.29 |
| 5 | 2.50 | (2.17 2.83) | 2.54 | −0.26 | −1.10 |
| 6 | 2.79 | (2.47 3.10) | 2.33 | −0.49 | −0.74 |
| 7 | 2.24 | (1.92 2.56) | 2.45 | 0.01 | −1.13 |
| 8 | 3.58 | (3.34 3.81) | 1.36 | −1.32 | 1.94 |
| 9 | 3.21 | (2.91 3.51) | 2.17 | −0.73 | −0.44 |
| 10 | 3.34 | (3.06 3.62) | 1.91 | −0.95 | 0.27 |
| 11 | 1.49 | (1.16 1.82) | 2.60 | 0.70 | −0.86 |
| 12 | 3.72 | (3.48 3.95) | 1.36 | −1.20 | 1.37 |
| 13 | 2.35 | (2.02 2.69) | 2.74 | −0.10 | −1.21 |
| 14 | 2.92 | (2.60 3.23) | 2.38 | −0.61 | −0.73 |
| 15 | 2.79 | (2.48 3.09) | 2.27 | −0.55 | −0.70 |
| 16 | 2.96 | (2.65 3.26) | 2.22 | −0.57 | −0.76 |
| 17 | 2.50 | (2.16 2.84) | 2.85 | −0.26 | −1.20 |
| 18 | 2.70 | (2.36 3.04) | 2.77 | −0.29 | −1.08 |
| 19 | 2.35 | (2.01 2.70) | 2.81 | −0.06 | −1.27 |
| 20 | 2.92 | (2.62 3.23) | 2.17 | −0.62 | −0.52 |
| 21 | 2.30 | (1.96 2.64) | 2.77 | −0.10 | −1.25 |
| 22 | 2.55 | (2.23 2.87) | 2.41 | −0.35 | −1.07 |
| 23 | 2.92 | (2.60 3.24) | 2.44 | −0.64 | −0.69 |
| 24 | 2.99 | (2.66 3.33) | 2.65 | −0.70 | −0.76 |
| 25 | 2.87 | (2.55 3.20) | 2.50 | −0.48 | −0.92 |
| 26 | 2.58 | (2.24 2.91) | 2.66 | −0.32 | −1.09 |
| 27 | 1.22 | (0.92 1.52) | 2.11 | 0.970 | −0.10 |
| 28 | 2.37 | (2.04 2.69) | 2.52 | −0.190 | −1.23 |
| 29 | 3.30 | (3.03 3.58) | 1.86 | −1.17 | 0.83 |
| 30 | 3.27 | (3.00 3.55) | 1.82 | −0.86 | 0.27 |

Table 2. Parallel analysis

| | % of variance | | |
|---|---|---|---|
| | Real-data | Mean of random | 95 percentile of random |
| 1 | 40.3* | 7.4 | 8.1 |
| 2 | 9.9* | 6.8 | 7.3 |
| 3 | 4.9 | 6.4 | 6.8 |
| 4 | 4.7 | 6.0 | 6.4 |
| 5 | 4.1 | 5.7 | 6.0 |
| 6 | 3.7 | 5.4 | 5.7 |

*Factors to retain.

Table 3. Bifactorial solution obtained

| # Item SCQ questionnaire | # Item MacLean *et al.* (2012) | Theoretical factor MacLean *et al.* (2012) | Factor 1 | Factor 2 | G1 (second order factor) |
|---|---|---|---|---|---|
| 2 | 1 | 3 | −0.28 | **0.73** | 0.46 |
| 5 | 2 | 2 | 0.03 | **0.48** | 0.45 |
| 6 | 3 | 4 | 0.05 | **0.60** | 0.57 |
| 9 | 4 | 1 | **0.69** | −0.10 | 0.38 |
| 12 | 5 | 1 | **0.54** | 0.16 | 0.51 |
| 14 | 6 | 1 | 0.29 | **0.34** | 0.50 |
| 15 | 7 | 3 | −0.28 | **0.92** | 0.63 |
| 18 | 8 | 2 | **0.66** | −0.03 | 0.42 |
| 22 | 9 | 1 | **0.67** | 0.03 | 0.49 |
| 23 | 10 | 4 | 0.20 | **0.56** | 0.64 |
| 29 | 11 | 3 | −0.64 | **0.96** | 0.43 |
| 30 | 12 | 2 | **0.78** | −0.21 | 0.34 |
| 34 | 13 | 3 | 0.24 | **0.53** | 0.64 |
| 35 | 14 | 1 | **0.74** | 0.02 | 0.52 |
| 36 | 15 | 1 | **0.73** | −0.01 | 0.48 |
| 41 | 16 | 1 | **0.85** | −0.13 | 0.47 |
| 43 | 17 | 2 | **0.46** | 0.34 | 0.62 |
| 47 | 18 | 1 | **0.77** | 0.01 | 0.53 |
| 48 | 19 | 3 | 0.19 | **0.63** | 0.69 |
| 54 | 20 | 1 | **0.51** | 0.25 | 0.57 |
| 55 | 21 | 1 | **0.59** | 0.11 | 0.50 |
| 65 | 22 | 3 | −0.03 | **0.78** | 0.68 |
| 69 | 23 | 1 | **0.51** | 0.15 | 0.49 |
| 73 | 24 | 1 | **0.69** | 0.03 | 0.50 |
| 74 | 25 | 1 | **0.63** | 0.12 | 0.53 |
| 77 | 26 | 1 | **0.64** | 0.23 | 0.65 |
| 80 | 27 | 2 | −0.17 | **0.48** | 0.31 |
| 83 | 28 | 1 | **0.79** | −0.04 | 0.50 |
| 86 | 29 | 4 | −0.03 | **0.52** | 0.44 |
| 87 | 30 | 2 | **0.68** | 0.00 | 0.46 |

SCQ, State of Consciousness Questionnaire. In bold font, the main loads of each item.




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Additionally, we explored the possibility that both factors could be represented by a suprafactor that links them. When the Schmid–Leiman transformation was applied, a second order factor effectively emerged (Table 3), in which both components showed high saturations (68.1 and 89.8, respectively), as all of the items showed (>.30). Considering the eigenvalue, prior to the rotation of the first of these two factors, where Carmines' theta is very close to 1 ($\theta = .943$), it cannot be discarded that the scale, as a whole, might be considered unidimensional as the best option.

*HRS*

In the first place, we conducted a confirmatory factorial analysis on the solution proposed by Riba *et al.* (2001) (71 items in 6 factors). In this case, the solution itself was identifiable, but goodness of fit indicators proved to be far from optimal values (GFI = 0.82; AGFI = 0.81; PGFI = 0.77; NFI = 0.76). Afterwards, we proceeded to undertake an exploratory analysis of the available data. The first set of solutions was obtained by using an optimized parallel analysis, suggesting the existence of factors in which none of the items showed their main load, as well as factors composed by very few items. Therefore, we conducted a preliminary study of items discrimination, eliminating those items that did not show high-corrected item-test correlation with any scale. This procedure led to the removal of 12 items, with 59 items remaining to restart the subsequent exploratory procedure. The descriptives of these items are shown in Table 4.

A polychoric correlation matrix was configured, attaining multivariate normality according to Mardia's criterion ($p < .001$). Data allowed for the utilization of a factor analysis (Barlett $p < 0.001$; KMO = 0.83). The optimized parallel analysis reported that there were six factors to retain (Table 5).

The full factorial analysis reported that the solution of 6 factors explained 56.5% of the common variance. A Simplimax rotation offered the load distribution displayed in Table 6.

The consistency of each multivariate factor reported values between 0.87 and 0.94. For the whole scale, the internal consistency was estimated with three statistics: $\theta = 0.94$; $\omega = 0.93$; $\alpha_s = 0.93$ (inter-factor correlations: lowest F3–F4 = 0.20; largest F2–F6 = 0.60). The model has generated few residues according to Kelley's criterion (RMSR = 0.051; expected mean value of RMSR for an acceptable model = 0.080), and provided excellent indicators of simplicity (Bentler's simplicity index S = 0.65, Percentile 100; Loading simplicity index LS = 0.40, Percentile 100). The derived scales also presented adequate internal consistency ($0.75 < \alpha < 0.90$), and all of the items displayed good discriminative capacities (>0.30 in all cases, except in the unique inversed item #44, which did not significantly increase

Table 4. Descriptive of the HRS items

| Item | Mean | Confidence interval 95% | Variance | Skewness | Kurtosis (zero centered) |
|---|---|---|---|---|---|
| 1 | 1.59 | (1.38 1.80) | 1.07 | 0.02 | −0.77 |
| 2 | 1.01 | (0.79 1.24) | 1.19 | 0.74 | −0.46 |
| 3 | 1.98 | (1.77 2.18) | 0.97 | −0.31 | −0.47 |
| 4 | 1.37 | (1.15 1.58) | 1.09 | 0.29 | −0.96 |
| 5 | 1.01 | (0.78 1.23) | 1.25 | 0.81 | −0.44 |
| 6 | 1.25 | (1.01 1.48) | 1.30 | 0.46 | −0.93 |
| 7 | 1.24 | (1.00 1.48) | 1.40 | 0.45 | −0.99 |
| 8 | 1.44 | (1.20 1.67) | 1.36 | 0.42 | −0.72 |
| 9 | 0.53 | (0.36 0.70) | 0.68 | 1.47 | 1.24 |
| 10 | 1.35 | (1.11 1.59) | 1.35 | 0.46 | −0.78 |
| 11 | 1.79 | (1.57 2.01) | 1.15 | −0.22 | −0.83 |
| 12 | 0.91 | (0.69 1.13) | 1.16 | 1.13 | 0.55 |
| 13 | 0.79 | (0.59 0.99) | 0.96 | 1.12 | 0.34 |
| 14 | 1.72 | (1.48 1.96) | 1.35 | 0.19 | −0.67 |
| 15 | 1.29 | (1.07 1.51) | 1.16 | 0.44 | −0.59 |
| 16 | 1.71 | (1.46 1.96) | 1.49 | 0.13 | −0.95 |
| 17 | 2.28 | (2.06 2.49) | 1.11 | −0.35 | −0.55 |
| 18 | 2.01 | (1.76 2.26) | 1.51 | −0.17 | −0.94 |
| 19 | 1.38 | (1.16 1.60) | 1.19 | 0.45 | −0.48 |
| 20 | 2.19 | (1.97 2.41) | 1.17 | −0.60 | −0.36 |
| 21 | 2.32 | (2.11 2.52) | 0.99 | −0.09 | −0.59 |
| 22 | 2.03 | (1.83 2.22) | 0.92 | −0.18 | −0.37 |
| 23 | 2.09 | (1.85 2.33) | 1.41 | −0.17 | −0.88 |
| 24 | 0.80 | (0.59 1.00) | 1.02 | 1.23 | 0.81 |
| 25 | 0.96 | (0.72 1.19) | 1.31 | 1.03 | 0.02 |
| 26 | 2.93 | (2.73 3.13) | 1.00 | −1.27 | 1.51 |
| 27 | 2.31 | (2.11 2.51) | 0.99 | −0.38 | −0.19 |
| 28 | 1.72 | (1.46 1.98) | 1.66 | −0.06 | −1.22 |
| 29 | 2.16 | (1.93 2.39) | 1.26 | −0.18 | −0.81 |
| 30 | 2.38 | (2.15 2.61) | 1.26 | −0.47 | −0.55 |
| 31 | 2.17 | (1.94 2.39) | 1.23 | −0.39 | −0.64 |
| 32 | 1.87 | (1.65 2.09) | 1.17 | −0.16 | −0.72 |
| 33 | 1.80 | (1.58 2.03) | 1.23 | −0.05 | −0.98 |
| 34 | 1.81 | (1.59 2.03) | 1.13 | 0.00 | −0.83 |
| 35 | 1.18 | (0.95 1.42) | 1.33 | 0.54 | −0.81 |
| 36 | 1.65 | (1.42 1.87) | 1.17 | 0.26 | −0.57 |
| 37 | 1.98 | (1.74 2.21) | 1.35 | −0.02 | −0.80 |
| 38 | 1.68 | (1.42 1.94) | 1.61 | 0.20 | −1.09 |
| 39 | 1.91 | (1.67 2.14) | 1.29 | −0.20 | −0.90 |
| 40 | 1.99 | (1.74 2.25) | 1.55 | −0.23 | −0.89 |
| 41 | 1.89 | (1.64 2.14) | 1.50 | −0.13 | −0.99 |
| 42 | 1.30 | (1.07 1.53) | 1.29 | 0.52 | −0.59 |
| 43 | 0.96 | (0.72 1.20) | 1.38 | 0.86 | −0.60 |
| 44 | 1.49 | (1.24 1.73) | 1.45 | 0.28 | −0.87 |
| 45 | 1.18 | (0.92 1.44) | 1.60 | 0.85 | −0.36 |
| 46 | 1.90 | (1.67 2.13) | 1.26 | −0.18 | −0.85 |
| 47 | 2.41 | (2.20 2.61) | 1.01 | −0.51 | −0.10 |
| 48 | 2.08 | (1.85 2.31) | 1.27 | −0.30 | −0.76 |
| 49 | 2.29 | (2.08 2.49) | 1.04 | −0.41 | −0.20 |
| 50 | 2.43 | (2.23 2.63) | 0.97 | −0.47 | 0.16 |
| 51 | 2.24 | (2.02 2.46) | 1.17 | −0.28 | −0.64 |
| 52 | 1.92 | (1.70 2.15) | 1.22 | −0.08 | −0.69 |
| 53 | 1.22 | (0.96 1.47) | 1.52 | 0.52 | −1.02 |
| 54 | 2.01 | (1.82 2.20) | 0.85 | −0.06 | −0.04 |
| 55 | 2.35 | (2.19 2.51) | 0.63 | −0.33 | 0.00 |
| 56 | 2.04 | (1.84 2.25) | 0.98 | −0.41 | −0.32 |
| 57 | 2.04 | (1.84 2.23) | 0.90 | −0.26 | −0.33 |
| 58 | 2.94 | (2.77 3.10) | 0.63 | −0.58 | 0.13 |
| 59 | 2.29 | (2.09 2.50) | 1.00 | −0.35 | 0.02 |

Table 5. Parallel analysis

| | % of variance | | |
|---|---|---|---|
| | Real-data | Mean of random | 95 percentile of random |
| 1 | 23.3* | 4.4 | 4.7 |
| 2 | 10.1* | 4.1 | 4.4 |
| 3 | 7.2* | 4.0 | 4.1 |
| 4 | 4.4* | 3.8 | 3.9 |
| 5 | 3.7* | 3.6 | 3.8 |
| 6 | 3.5* | 3.5 | 3.6 |
| 7 | 2.9 | 3.4 | 3.5 |

the consistency of the scale after being removed, so it was retained).

### ARCI

The theoretical structure of this questionnaire is compounded by five dimensions, linking many of the 49 items to two or more of these scales (Martin *et al.,* 1971; Lamas *et al.,* 1994a). It was not possible with our data to conduct a confirmatory approach using standard methods. This was followed by the exploratory study. The descriptives of ARCI items are displayed in Table 7.

A tetrachoric matrix correlation was configured. The resulting matrix was not positively defined, so the application of a smooth algorithm was required, although it attained the multivariate normality (Mardia = 0.08). Because of the existence of items with kurtosis out of the range of −1/+1, this leads to the possibility to perform the tetrachoric matrix correlation. Despite these limitations, it was possible to perform a factorial analysis (Barlett $p < 0.001$; KMO = 0.74). The parallel analysis offered as best solution a three-factor structure; however, after performing the overall analysis it accounted only for the 26.0% of the common variance. The usual Factor Minimum Analysis Rank could not be applied to obtain the factorial extraction from the tetrachoric matrix correlations, so it was necessary to again utilize the Unweighted Least Squares method. After performing a Simplimax rotation we observed that only 18 of the 49 items presented significant loads in any of these 3 factors, while the remaining 31 had no significant loadings (>0.20) in any of them (Table 8).

This solution proved to be empirically unacceptable. When only the 18 items with significant factorial loadings were used, the solution displayed adequate fit indicators (GFI = 0.96; AGFI = 0.95; NFI = 0.93; RFI = 0.92), and the scales showed good multivariate consistency indicators (θ = 0.92, 0.89, and 0.86; αs = 0.85, 0.81, and 0.79, respectively). The inter-factor correlation was F1–F2 = 0.03, F1–F3 = 0.14, F2–F3 = 0.01. However, despite this solution obtained through adequate simplicity indicators (Bentler's S = 0.99, Percentile 100; LS = 0.89, Percentile 100), and generating few residues (RMSR obtained = 0.070, expected mean value of RMSR for an acceptable model = 0.080), it only explained 50.5% of the common variance, and the internal consistency that resulted was precarious (θ = 0.75, ω = 0.51, αs = 0.73).

### Correlations between the factorial derived subscales

The correlations between the different factorial derived scales, with the labels that we assigned to each factor, are shown in Table 9.

Regarding the correlations between different subscales for each specific questionnaire: all the subscales of the MEQ correlate ($p < 0.0004$ after Bonferroni correction) positively between themselves. For the HRS, only absence of correlation was found between Agitation (AG) with Sensitive Distortion (SD), Security/Control (SC) and Visual Distortion (VD). And for the ARCI, Activation (ACT) correlated positively with Euphoria (EUP), and negatively with Sedations (SED). No correlation was found between SED and EUP.

Regarding the correlations between the different subscales from all the questionnaires, there is a general patron of correlation between the MEQ and the HRS. Only AG does not correlate with ME and MEQTotal. EUP correlate with ME and MEQTotal of the MEQ, and with SD and SC of the HRS.

## DISCUSSION

In this paper we have analyzed the factorial structure and internal consistency of three of the most widely used rating scales destined to measure the subjective effects of psychedelics: the MEQ (MacLean *et al.,* 2012), the HRS (Strassman *et al.,* 1994; Riba *et al.,* 2001), and the 49-item version of the ARCI (Martin *et al.,* 1971; Lamas *et al.,* 1994a). From these three rating scales, only MEQ has been explored with modern psychometric techniques (MacLean *et al.,* 2012; Barrett *et al.,* 2015). HRS and ARCI have only been subjected to psychometric research to a limited extent, but not extensive enough to be considered appropriate instruments of measure. Furthermore, the limited psychometric analyses undertaken a few decades ago (Lamas *et al.,* 1994a; Riba *et al.,* 2001) were based on psychometric approaches surpassed nowadays (Seva and Ferrando, 2000). Despite these important limitations, HRS and ARCI are widely used at present. Consequently, there is a need for revising the



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Table 6. Factorial solution on the 59 HRS selected items

| Item # | # HRS | F1 | F2 | F3 | F4 | F5 | F6 | $r_{it}$ | α multivariate (univariate) | SB |
|---|---|---|---|---|---|---|---|---|---|---|
| 30 | 55 | **0.74** | 0.10 | 0.03 | −0.02 | −0.02 | 0.02 | 0.63 | | Per |
| 29 | 54 | **0.71** | 0.12 | −0.03 | −0.08 | 0.02 | 0.01 | 0.61 | | Per |
| 27 | 49 | **0.53** | −0.02 | −0.02 | 0.02 | −0.11 | 0.00 | 0.31 | | Afc |
| 32 | 58 | **0.44** | −0.01 | 0.00 | 0.01 | 0.58 | −0.05 | 0.57 | | Per |
| 34 | 60 | **0.43** | −0.15 | 0.00 | 0.23 | 0.47 | 0.02 | 0.58 | | Per |
| 20 | 40 | **0.38** | 0.04 | 0.25 | 0.32 | −0.13 | 0.10 | 0.43 | | Afc |
| 33 | 59 | **0.37** | 0.08 | 0.09 | 0.34 | 0.51 | −0.23 | 0.59 | | Per |
| 28 | 52 | **0.26** | 0.20 | 0.19 | −0.11 | −0.02 | 0.09 | 0.31 | 0.87 (0.79) | Per |
| 19 | 37 | −0.12 | **0.72** | 0.02 | 0.28 | −0.15 | 0.03 | 0.58 | | Afc |
| 2 | 6 | 0.11 | **0.68** | 0.14 | 0.09 | 0.15 | −0.34 | 0.61 | | Som |
| 43 | 71 | −0.10 | **0.65** | 0.01 | 0.02 | 0.30 | −0.21 | 0.58 | | Cog |
| 15 | 30 | 0.15 | **0.61** | 0.20 | 0.03 | −0.03 | −0.08 | 0.63 | | Afc |
| 1 | 5 | 0.22 | **0.60** | 0.04 | −0.19 | 0.15 | −0.39 | 0.43 | | Som |
| 10 | 21 | 0.11 | **0.57** | −0.10 | 0.19 | 0.22 | −0.14 | 0.58 | | Som |
| 14 | 29 | 0.03 | **0.54** | −0.03 | 0.37 | −0.11 | −0.01 | 0.46 | | Afc |
| 22 | 42 | 0.02 | **0.53** | −0.08 | −0.08 | 0.00 | 0.14 | 0.49 | | Afc |
| 44 | 74 | 0.29 | **0.48** | 0.13 | −0.21 | 0.03 | −0.02 | 0.57 | | Cog |
| 48 | 80 | 0.32 | **0.47** | −0.06 | −0.11 | 0.07 | 0.10 | 0.60 | | Cog |
| 4 | 8 | −0.01 | **0.46** | 0.43 | −0.03 | −0.09 | −0.17 | 0.39 | | Som |
| 42 | 69 | −0.26 | **0.44** | −0.02 | 0.44 | 0.50 | −0.39 | 0.34 | | Per |
| 52 | 86 | 0.29 | **0.44** | 0.00 | −0.10 | 0.21 | −0.02 | 0.59 | | Cog |
| 21 | 41 | −0.03 | **0.43** | −0.01 | −0.08 | −0.11 | 0.42 | 0.49 | | Afc |
| 11 | 22 | 0.22 | **0.41** | 0.09 | −0.03 | 0.15 | −0.03 | 0.53 | | Per |
| 16 | 31 | 0.19 | **0.36** | 0.09 | −0.02 | 0.00 | 0.26 | 0.55 | 0.91 (0.88) | Afc |
| 6 | 10 | −0.12 | 0.06 | **0.88** | 0.18 | −0.02 | −0.03 | 0.71 | | Som |
| 7 | 11 | −0.18 | −0.01 | **0.86** | 0.14 | 0.04 | 0.03 | 0.72 | | Som |
| 8 | 16 | −0.01 | −0.33 | **0.58** | −0.25 | 0.00 | 0.42 | 0.53 | | Som |
| 5 | 9 | 0.00 | 0.09 | **0.58** | 0.02 | −0.12 | −0.16 | 0.40 | | Som |
| 13 | 26 | −0.12 | −0.13 | **0.53** | −0.19 | 0.00 | 0.44 | 0.56 | | Afc |
| 3 | 7 | 0.06 | −0.15 | **0.51** | 0.20 | 0.08 | 0.26 | 0.46 | | Som |
| 9 | 17 | 0.08 | 0.02 | **0.50** | −0.01 | 0.11 | −0.07 | 0.41 | 0.91 (0.81) | Per |
| 17 | 32 | −0.02 | 0.26 | −0.24 | **0.67** | 0.02 | 0.01 | 0.62 | | Afc |
| 18 | 33 | 0.00 | −0.02 | 0.22 | **0.53** | 0.01 | 0.22 | 0.47 | | Afc |
| 26 | 47 | 0.16 | 0.34 | −0.12 | **0.53** | −0.11 | −0.02 | 0.52 | | Afc |
| 56 | 93 | 0.22 | −0.24 | 0.04 | **0.52** | −0.21 | 0.37 | 0.54 | | Vol |
| 55 | 92 | 0.20 | 0.07 | −0.07 | **0.51** | −0.12 | 0.25 | 0.62 | | Vol |
| 23 | 43 | 0.14 | 0.21 | −0.01 | **0.51** | 0.12 | −0.10 | 0.50 | | Afc |
| 25 | 45 | −0.23 | 0.32 | 0.17 | **0.44** | 0.06 | 0.02 | 0.34 | | Afc |
| 57 | 94 | 0.21 | 0.15 | −0.25 | **0.41** | −0.22 | 0.09 | 0.47 | | Vol |
| 54 | 91 | 0.28 | −0.20 | 0.13 | **0.31** | −0.16 | 0.25 | 0.37 | | Vol |
| 24 | 44 | 0.01 | 0.19 | 0.31 | **−0.37** | 0.15 | 0.03 | −0.20 | 0.90 (0.75) | Afc |
| 37 | 64 | −0.14 | 0.03 | −0.19 | −0.02 | **0.82** | 0.25 | 0.81 | | Per |
| 41 | 68 | −0.07 | 0.11 | −0.23 | −0.02 | **0.78** | 0.23 | 0.81 | | Per |
| 39 | 66 | 0.10 | −0.02 | −0.08 | 0.24 | **0.75** | −0.04 | 0.68 | | Per |
| 38 | 65 | −0.01 | 0.21 | −0.27 | 0.00 | **0.74** | 0.01 | 0.75 | | Per |
| 31 | 57 | 0.01 | −0.01 | −0.11 | 0.03 | **0.74** | 0.17 | 0.74 | | Per |
| 40 | 67 | 0.00 | 0.15 | −0.19 | 0.15 | **0.64** | 0.02 | 0.63 | | Per |
| 35 | 61 | 0.36 | −0.15 | −0.02 | −0.22 | **0.62** | 0.01 | 0.53 | | Per |
| 36 | 62 | 0.08 | −0.08 | 0.01 | 0.01 | **0.54** | 0.22 | 0.55 | 0.94 (0.90) | Per |
| 58 | 98 | 0.02 | −0.15 | 0.01 | 0.14 | 0.25 | **0.64** | 0.54 | | Int |
| 59 | 99 | 0.01 | 0.00 | 0.01 | −0.28 | 0.01 | **0.64** | 0.55 | | Int |
| 47 | 77 | −0.22 | 0.01 | 0.00 | 0.52 | −0.02 | **0.61** | 0.50 | | Cog |
| 51 | 85 | −0.15 | −0.12 | 0.19 | 0.41 | −0.01 | **0.60** | 0.51 | | Cog |
| 53 | 88 | −0.14 | −0.02 | 0.12 | −0.15 | −0.08 | **0.58** | 0.44 | | Cog |
| 45 | 75 | −0.02 | 0.01 | 0.10 | −0.52 | 0.13 | **0.57** | 0.44 | | Cog |
| 50 | 82 | 0.14 | 0.13 | 0.00 | −0.01 | −0.07 | **0.55** | 0.56 | | Cog |
| 49 | 81 | 0.10 | 0.27 | −0.02 | 0.27 | −0.20 | **0.51** | 0.54 | | Cog |
| 12 | 25 | 0.02 | −0.22 | 0.42 | −0.34 | −0.06 | **0.50** | 0.33 | | Afc |
| 46 | 76 | 0.16 | 0.21 | −0.06 | 0.04 | 0.02 | **0.42** | 0.50 | 0.91 (0.81) | Cog |

NOTE: #, Number of item in the 59-item version; #, Number of item in the 99-item version; F1, F2…, Factors obtained in the analysis; $r_{it}$, correlation of the item with its subscale, once excluded from it; α, Cronbach's alpha of the resultant scale; SB, Scale belonging to Riba *et al.* (2001) version. In bold font, the main loads of each item.



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Table 7. Descriptive of ARCI items

| Item | Mean | Confidence interval 95% | Variance | Skewness | Kurtosis (zero centered) |
|---|---|---|---|---|---|
| 1 | 0.50 | (0.40 0.60) | 0.25 | 0.00 | −1.99 |
| 2 | 0.65 | (0.55 0.74) | 0.23 | −0.61 | −1.62 |
| 3 | 0.46 | (0.35 0.56) | 0.25 | 0.18 | −1.96 |
| 4 | 0.70 | (0.60 0.79) | 0.21 | −0.86 | −1.26 |
| 5 | 0.32 | (0.23 0.42) | 0.22 | 0.76 | −1.42 |
| 6 | 0.24 | (0.15 0.33) | 0.18 | 1.22 | −0.51 |
| 7 | 0.42 | (0.32 0.52) | 0.24 | 0.34 | −1.88 |
| 8 | 0.72 | (0.62 0.81) | 0.20 | −0.96 | −1.08 |
| 9 | 0.10 | (0.04 0.15) | 0.09 | 2.78 | 5.69 |
| 10 | 0.33 | (0.23 0.43) | 0.22 | 0.73 | −1.46 |
| 11 | 0.48 | (0.37 0.58) | 0.25 | 0.10 | −1.98 |
| 12 | 0.63 | (0.53 0.73) | 0.23 | −0.56 | −1.69 |
| 13 | 0.43 | (0.33 0.53) | 0.25 | 0.28 | −1.91 |
| 14 | 0.73 | (0.64 0.82) | 0.20 | −1.07 | −0.86 |
| 15 | 0.30 | (0.21 0.40) | 0.21 | 0.86 | −1.26 |
| 16 | 0.39 | (0.29 0.49) | 0.24 | 0.47 | −1.77 |
| 17 | 0.78 | (0.69 0.86) | 0.17 | −1.35 | −0.18 |
| 18 | 0.61 | (0.51 0.71) | 0.24 | −0.47 | −1.77 |
| 19 | 0.52 | (0.42 0.62) | 0.25 | −0.08 | −1.99 |
| 20 | 0.51 | (0.40 0.61) | 0.25 | −0.03 | −1.99 |
| 21 | 0.79 | (0.71 0.87) | 0.17 | −1.44 | 0.07 |
| 22 | 0.48 | (0.37 0.58) | 0.25 | 0.10 | −1.98 |
| 23 | 0.61 | (0.51 0.71) | 0.24 | −0.44 | −1.80 |
| 24 | 0.23 | (0.14 0.31) | 0.18 | 1.31 | −0.30 |
| 25 | 0.40 | (0.30 0.50) | 0.24 | 0.42 | −1.82 |
| 26 | 0.71 | (0.62 0.80) | 0.21 | −0.93 | −1.14 |
| 27 | 0.67 | (0.57 0.77) | 0.22 | −0.73 | −1.46 |
| 28 | 0.54 | (0.44 0.64) | 0.25 | −0.15 | −1.97 |
| 29 | 0.51 | (0.41 0.61) | 0.25 | −0.05 | −1.99 |
| 30 | 0.63 | (0.53 0.73) | 0.23 | −0.53 | −1.72 |
| 31 | 0.53 | (0.43 0.63) | 0.25 | −0.13 | −1.98 |
| 32 | 0.30 | (0.21 0.40) | 0.21 | 0.86 | −1.26 |
| 33 | 0.78 | (0.69 0.86) | 0.17 | −1.35 | −0.18 |
| 34 | 0.48 | (0.38 0.58) | 0.25 | 0.08 | −1.99 |
| 35 | 0.73 | (0.64 0.82) | 0.20 | −1.03 | −0.94 |
| 36 | 0.11 | (0.05 0.18) | 0.10 | 2.45 | 3.95 |
| 37 | 0.44 | (0.34 0.54) | 0.25 | 0.23 | −1.94 |
| 38 | 0.66 | (0.56 0.76) | 0.23 | −0.67 | −1.55 |
| 39 | 0.41 | (0.30 0.51) | 0.24 | 0.39 | −1.84 |
| 40 | 0.44 | (0.34 0.54) | 0.25 | 0.26 | −1.93 |
| 41 | 0.26 | (0.17 0.35) | 0.19 | 1.10 | −0.78 |
| 42 | 0.31 | (0.22 0.40) | 0.21 | 0.83 | −1.32 |
| 43 | 0.23 | (0.15 0.32) | 0.18 | 1.26 | −0.41 |
| 44 | 0.46 | (0.35 0.56) | 0.25 | 0.18 | −1.96 |
| 45 | 0.68 | (0.59 0.78) | 0.22 | −0.79 | −1.37 |
| 46 | 0.08 | (0.03 0.14) | 0.08 | 3.06 | 7.31 |
| 47 | 0.47 | (0.37 0.57) | 0.25 | 0.13 | −1.98 |
| 48 | 0.17 | (0.09 0.24) | 0.14 | 1.82 | 1.30 |
| 49 | 0.74 | (0.65 0.83) | 0.19 | −1.10 | −0.78 |

Table 8. Trifactorial solution from ARCI items

| | Founded factors | | | Theoretical scales | | | | |
|---|---|---|---|---|---|---|---|---|
| Item | F1 | F2 | F3 | E1 | E2 | E3 | E4 | E5 |
| 21 | **0.85** | 0.00 | 0.00 | | 2 | | | |
| 19 | **0.83** | −0.05 | 0.00 | | 2 | | | |
| 22 | **0.77** | −0.06 | 0.00 | | 2 | 3 | | |
| 17 | **0.75** | −0.04 | 0.00 | | 2 | | | |
| 20 | **0.64** | 0.00 | 0.00 | | 2 | | | |
| 14 | **0.60** | −0.02 | 0.00 | | 2 | | | |
| 27 | **0.26** | −0.01 | 0.00 | | 2 | | | 5 |
| 33 | **0.21** | −0.02 | 0.00 | | | 3 | | 5 |
| 23 | 0.04 | **0.92** | 0.01 | 1 | 2 | | 4 | |
| 29 | 0.04 | **0.81** | 0.01 | 1 | | | | 5 |
| 11 | −0.02 | **−0.78** | 0.00 | 1 | | 3 | | |
| 12 | 0.18 | **0.38** | −0.01 | 1 | | | | |
| 4 | 0.00 | 0.27 | **0.89** | 1 | | | | |
| 38 | 0.00 | 0.23 | **0.74** | | | | 4 | |
| 8 | 0.00 | 0.16 | **0.65** | 1 | | | | |
| 2 | 0.00 | 0.14 | **0.54** | 1 | | | | |
| 3 | 0.00 | 0.12 | **0.41** | 1 | | | | |
| 36 | 0.00 | −0.11 | **−0.40** | | | | 4 | |
| 5 | 0.00 | −0.07 | 0.10 | 1 | | | | |
| 6 | 0.00 | −0.06 | 0.04 | 1 | | | | |
| 47 | 0.00 | 0.05 | 0.20 | | | 3 | | |
| 32 | 0.09 | 0.05 | 0.00 | | | | 4 | 5 |
| 42 | 0.00 | 0.04 | 0.16 | | | 3 | | |
| 43 | 0.00 | 0.02 | 0.11 | | | 3 | | |
| 35 | 0.00 | −0.02 | 0.06 | | | 3 | | 5 |
| 39 | 0.00 | 0.01 | 0.05 | | | | 4 | |
| 13 | 0.14 | −0.01 | 0.00 | | 2 | | | |
| 26 | 0.00 | 0.01 | 0.00 | | 2 | | 4 | 5 |
| 7 | 0.00 | −0.01 | 0.03 | 1 | | | | |
| 41 | 0.00 | 0.01 | 0.03 | | | 3 | | |
| 31 | 0.03 | 0.01 | 0.00 | | | | 4 | 5 |
| 10 | 0.00 | 0.01 | 0.08 | 1 | | | 4 | |
| 46 | −0.06 | 0.01 | 0.00 | | | 3 | | |
| 40 | 0.00 | 0.01 | 0.02 | | | | 4 | |
| 37 | 0.00 | 0.00 | −0.02 | | | | 4 | |
| 24 | 0.04 | 0.00 | 0.00 | | 2 | | | 5 |
| 1 | 0.00 | 0.00 | 0.03 | 1 | | | | |
| 16 | 0.02 | 0.00 | 0.00 | | 2 | | | |
| 9 | −0.05 | 0.00 | 0.01 | 1 | | | | |
| 44 | −0.01 | 0.00 | 0.01 | | | 3 | | |
| 15 | 0.06 | 0.00 | 0.00 | | 2 | | | |
| 49 | 0.06 | 0.00 | −0.01 | | | 3 | | |
| 25 | 0.01 | 0.00 | 0.00 | | 2 | | | 5 |
| 18 | 0.00 | 0.00 | 0.00 | | 2 | | | |
| 34 | 0.00 | 0.00 | 0.00 | | | 3 | 4 | 5 |
| 30 | 0.00 | 0.00 | −0.01 | | | | 4 | 5 |
| 45 | 0.00 | 0.00 | 0.00 | | | 3 | | |
| 48 | 0.00 | 0.00 | 0.00 | 1 | | 3 | | |
| 28 | 0.00 | 0.00 | 0.00 | | 2 | | 4 | |

NOTE: In bold, major loads for each factor. In the theoretical scales, underlined items should be reversed.

psychometrics of these rating scales according to modern statistical techniques (Lorenzo-Seva and Ferrando, 2006).

It was not until very recently that the factorial structure and reliability of MEQ—a questionnaire that had different names and versions over time and was extensively used in early psychedelic research (Pahnke, 1963; Pahnke, 1969; Doblin, 1991), and more recently in clinical research with the name of States of Consciousness Questionnaire (SCQ) (Griffiths *et al.*, 2006, 2008, 2011)—were analyzed. MacLean *et al.* (2012) explored the factorial structure and reliability of this questionnaire with psilocybin users after retrospective assessment via the Internet and found a solution in which 30 items loaded four factors, labeled as: Mystical (containing items from the former subscales Internal and external unity, Noetic quality, and Sense of sacredness); Positive mood (including items



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Table 9. Pearson's correlations between the factorial derived scales for the three questionnaires

| | Transdimen-sionality | Total | Sensitive distortion | Cognitive distortion | Agitation | Security/ control | Visual distortion | Quality of the experience | Euphoria | Activation | Sedation |
|---|---|---|---|---|---|---|---|---|---|---|---|
| *MEQ* | | | | | | | | | | | |
| Mystical ecstasy | 0.61* | 0.95* | 0.50* | 0.52* | 0.10 | 0.78* | 0.36* | 0.45* | 0.45* | 0.17 | −0.26 |
| Transdimen-sionality | | 0.83* | 0.52* | 0.70* | 0.30* | 0.45* | 0.48* | 0.55* | 0.16 | 0.02 | 0.06 |
| Total | | | 0.56* | 0.65* | 0.19 | 0.73* | 0.45* | 0.54* | 0.40* | 0.13 | 0.01 |
| *HRS* | | | | | | | | | | | |
| Sensitive distortion | | | | 0.60* | 0.19 | 0.54* | 0.63* | 0.38* | 0.33* | 0.26 | −0.03 |
| Cognitive distortion | | | | | 0.36* | 0.49* | 0.57* | 0.56* | 0.24 | 0.23 | 0.00 |
| Agitation | | | | | | 0.02 | 0.18 | 0.43* | −0.02 | −0.09 | 0.09 |
| Security/ control | | | | | | | 0.33* | 0.42* | 0.49* | 0.25 | −1.85 |
| Visual distortion | | | | | | | | 0.40* | 0.17 | 0.19 | 0.08 |
| Quality of the experience | | | | | | | | | 0.06 | 0.07 | 0.07 |
| *ARCI* | | | | | | | | | | | |
| Euphoria | | | | | | | | | | 0.37* | −0.07 |
| Activation | | | | | | | | | | | −0.42* |

*Significative correlation alter Bonferroni's correction ($p < 0.0004$).

related to the previous Deeply felt positive mood); Time/Space (including items from the former Transcendence of time and space); and Ineffability (including items of the previous Ineffability and paradoxicality). In a recent study, Barrett *et al.* (2015) confirmed, in a series of clinical studies using psilocybin, the structure found by MacLean *et al.* (2012). We tried to conduct a confirmatory factorial analysis with the 30 items grouped in the four-factor structure that MacLean *et al.* (2012) proposed, but the model was not recognized by the analysis performed with our data. In a subsequent exploratory factor analysis we found a two-factor model that explained 59.11% of the common variance, a figure similar to those found by MacLean *et al.* (2012) (57% and 64%, respectively). Our Factor 1 grouped the items belonging to the MacLean *et al.* (2012) subscales Mystical, and Positive mood, excepting items 14 (Factor 1), and items 5 and 80 (Factor 2 of MacLean's model); and our Factor 2 grouped the subscales Space/Time, and Ineffability plus items 5, 14, and 80 of MacLean's model. In this sense, we found a factorial structure very similar to the one obtained by MacLean *et al.* (2012) and Barrett *et al.* (2015), which increases the suitability of the basic structure found by those authors. Tentatively, we relabeled these two factors as Mystical ecstasy and Transdimensionality. The internal consistency of the whole test as well as of each of the two factors resulted in excellent indices. MacLean *et al.* (2012) found a reliability figure for the 30-item scale ($\alpha = .93$) similar to ours (multivariate indices: $\theta = 0.94$; $\omega = 0.94$). Furthermore, the two-factor structure we obtained displayed equal or similar reliability indices for each subscale of those found by MacLean *et al.* (2012), although direct comparison cannot be established because of factor structure differences. Finally, we explored the possibility that the two factors we got constituted a suprafactor, or a second order factor, with both components showing high saturations (68.1 and 89.2, respectively), as the 30 items did (>0,30). Thus, MEQ may conform as a unifactorial questionnaire that measures Mystical Experiences. Conceptually, this finding could be consistent with the conceptions asserting that, under a mystical experience, "all is one" (Stace, 1960). The differences between the MacLean *et al.* (2012) and Barrett *et al.* (2015) studies and ours with regard to the few differences in the MEQ factor structure may have different explanations: (i) differences in the sample size; (ii) differences in the conditions in which the questionnaire is answered (anonymous retrospective assessment via Internet vs. a clinical setting vs. natural conditions in the presence of the researchers just after the experience); (iii) possible dissimilarities in the subjective effects of the substances considered (psilocybin vs. ayahuasca); and (iv) cultural differences between the samples. The MEQ is answered from 0 (minimum score) to 5 (maximum score), so the median values are between 2 and 3 (2.5). In our sample, only 2 items are below 2, and 5 items are between 2 and 2.5; and the rest of items are above the median value. So small discrepancies between our model and MacLean's model probably do not lie in eventual low scores yielded by our sample.

Future studies should cover more culturally diverse samples, taking into account different study settings and incorporating a wider range of substances in order to define the most suitable MEQ factor structure. Furthermore, the good indices of internal consistence obtained for the whole scale and the different proposed subscales in both studies, seem to indicate that the



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30-item MEQ is a reliable measure for the study of mystical mimetic effects of hallucinogens.

With respect to HRS, this study is the first to analyze its factorial structure following an EFA. The psychometrics of the Strassman *et al.* (1994) original version were developed after performing a principal components factor analysis based on 11 subjects, after they had received four different doses of DMT, plus a placebo dose. These authors did not report the items loadings, the percentage of explained variances, or the eventual reliability indices. A subsequent analysis of principal components was conducted over the subscales of the 71-item version of the HRS, and applied to two different samples (one of them following an ayahuasca experience). The results informed variances between 68% and 75%, respectively, for the whole test (Riba *et al.,* 2001). They also found good reliability indices for four subscales (Affect, Cognition, Perception, and Somaesthesia), but inadequate indices for Volition and Intensity. The Confirmatory Factor Analysis we conducted with HRS items did not support the original HRS theoretical model. After applying the pertinent psychometric analyses, we retained 59 items that were distributed in 6 factors. These 6 factors where composed by a set of items different from those proposed by Strassman *et al.* (1994). In our study, the percentage of the explained variance was lower (56.5%) than that obtained by Riba *et al.* (2001) (75–68%). Regarding reliability, while Riba *et al.* (2001) found two subscales with inadequate univariate internal consistency indices, all the subscales we obtained presented good or excellent reliability parameters. Our study also included calculations on multivariate reliability indices, finding excellent figures for the six subscales. In any case, because the subscales in our proposed version of HRS are composed by different items compared to the version described by Riba *et al.* (2001), direct comparisons between them cannot be established. Because the subscales we developed showed good or excellent internal consistency indices, it seems plausible to consider that the item reconfiguration we propose may constitute a more suitable scale. In this sense, we also calculated the multivariate reliability indices for the whole scale, finding again excellent indices ($\theta = 0.94$; $\omega = 0.93$; $\alpha_s == 0.93$). Despite the relatively low percentage of common variance found, we obtained at the same time a factor solution with few residues and excellent indices of simplicity, indicative of a good suitability of the resulting model. All the items in our version also showed a good discriminative capacity. Considering that the model proposed by Strassman *et al.* (1994) was only based on 11 subjects, and that neither data on the item distribution nor figures on the items loading were reported, we considered our model as more appropriate. Furthermore, as a result of the recent advances in statistical methodologies that allow for more sophisticated psychometric analyses based on tetrachoric correlation matrices, nowadays considered a more adequate statistical approach to perform AFE (Ferrando and Lorenzo-Seva, 2014), the model we obtained could be considered more appropriate to analyze the HRS scores, at least in the assessment of the effects of ayahuasca. Lastly, we relabeled the 6 factors with the following tentative names: Sensorial distortion (8 items), Cognitive distortion (16 items), Agitation (7 items), Security/Control (10 items), Visual distortion (8 items), and Quality of the experience (10 items). Future studies utilizing larger samples and different psychedelics should confirm or reject these findings.

With regard to the ARCI 49-item short form (Martin *et al.,* 1971), as far as we are aware, there are no studies whose factorial structure had been researched. Lamas *et al.* (1994a) performed a discriminant analysis of the different subscales, finding discriminations among PCAG, MBG, LSD, and BG, but not for A. The reliability analysis showed good indices for PCAG, MBG, and BG, but unacceptable indices for A and LSD. In our study, it was not possible to undertake a confirmatory factorial analysis because of ARCI theoretic structure, whose five dimensions contain items belonging to two or more subscales. In the psychometric analysis we conducted, we found an 18-item solution with three factors, which explains 50.5% of the common variance. The reliability indices for the whole test proved to be precarious. At the same time, the three factors were relabeled, each of them obtaining an excellent multivariated internal reliability. The tentative names we propose for the new three factors are: Euphoria (8 items), Activation (4 items), and Sedation (6 items). Because the subscales of the original version of the 49-items ARCI are composed by items different from those informing the subscales, it is not possible to establish direct comparisons between their internal consistency indices. To our knowledge, there are no data on explained variance of the items within the 49-item ARCI. Although we found a low percentage of variance in our 18-item version, and a precarious internal consistency for the whole scale, multivariate indices in each subscale were adequate, so they may have certain heuristic value if used in psychedelic research. Finally, the ARCI questionnaire was developed to assess subjective effects and abuse potential of drugs pertaining to different pharmacological categories. That is why it is necessary to develop further psychometric studies incorporating other



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psychoactive drugs utilizing this rating scale before considering that we have a final version of the questionnaire. In any case, and based on our analysis, ARCI-49 seems to not be a feasible questionnaire for use in psychedelic research, at least with respect to ayahuasca.

In relation to the correlations obtained between the different subscales, it is very interesting to note that the MEQ subscale Mystical Ecstasy (ME) did not correlate with Agitation (AG), and did not correlate with Activation and with Sedation (SED). The other subscale of the MEQ, Transdimensionality (TD) correlated with all subscales of the HRS, but with none of the ARCI. And the Total score of the MEQ did not correlate with the AG, ACT and SED but correlated with EUP. Thus, it seems that having a full psychedelic experience without agitation (assessed with the HRS), activation and sedation (assessed with the ARCI), but having euphoria (assessed by the ARCI), may be a good map of the mystical experience achieved by our subjects under the effects of ayahuasca.

The correlation analysis between the HRS subscales and the ARCI subscales is also interesting, showing that sedation is not a component of the psychedelic experience, but euphoria may be part of that, because it correlates positively with 2 of the 6 subscales of the HRS.

Another interesting result emerging from the correlation analyses refers to the ARCI. We found a single significant positive correlation between subscales EUP and ACT, a negative correlation between ACT and SED, and no significant correlation between EUP and SED. The ARCI is an instrument used to measure the effects of different pharmacological classes of drugs, so each subscale should ideally measure a different effect and thus reflect effects of different kinds of drugs. The interesting pattern of correlations found in our sample, beside the good reliability indices reached in each subscale, may led to considerer further explorations of this new version of the ARCI.

Finally, the positive and significant correlations between the MEQ subscales and the HRS subscales (except Agitation), may be reflecting two very dependent aspects of the psychedelic experience, the psychedelic one and the mystical one, two aspects of the same experience that could be named mystical psychedelic experience and that tend to occur in the absence of agitation. Because Euphoria correlates also with two of three subscales of the MEQ and with another two subscales of the HRS, it is quite possible that euphoria may also be an essential component of the psychedelic mystical experience.

### *Limitations, future challenges, and conclusions*

Although our study was carried out in subjects following an ayahuasca experience (*in situ*), and the sample size fulfilled the statistical requirements to perform confirmatory and exploratory factor analysis, larger samples are required in order to explore if explained common variances at the different rating scales could be improved. At the same time, the questionnaires were administered after the use of a single psychedelic substance (ayahuasca). Thus, future studies should incorporate more substances aiming to confirm or reject the factorial structures we found. In the case of different substances, including other hallucinogens with dissimilar mechanisms of action (like *S. divinorum*, or ketamine) some items from ARCI and HRS, which were eliminated in our analysis, could be maintained. Likewise, some of the HRS items we eliminated could be of interest as descriptive items. Besides, it may be interesting to develop psychometric studies using these rating scales in the exploration of subjective effects of distinct altered states of consciousness, such as meditation or holotropic breathwork (Rhinewine and Williams, 2007). It is also necessary to undertake studies replicating the aforementioned framework and to evaluate the results obtained before considering our proposals as definitive.

There exists quite an expansive body of literature that employs the three rating scales explored in our study (see the Introduction section for a comprehensive overview). Therefore, the results emerging from some of this research should be interpreted with caution. In this sense, future studies exploring the subjective effects of psychedelics should take into account the strong limitations of the mentioned rating scales whenever researchers plan to use them. For the moment, from all the three questionnaires analyzed in our work, only the MEQ version developed by MacLean *et al.* (2012) seems to be reliable and a valid instrument to assess the subjective effects of hallucinogens for US population, while its factor structure should be further studied in transcultural psychopharmacological research. In this respect, we offer here a first effort of transcultural translation to the Spanish language. Regarding the HRS and ARCI questionnaires, our study may be the only consistent research based on EFA that has been undertaken so far. Furthermore, because the previous studies exploring the reliability subscales of both rating scales seem incomplete, these instruments may be improved by proposing new tentative items intended to improve their psychometric properties. In the meantime, the HRS and ARCI versions we proposed could fill this gap. Finally, all the rating scales destined to be used in psychopharmacology research might be psychometrically analyzed according to these new statistical methods which are based, in the case of the Exploratory Factor Analysis, on polychoric and tetrachoric matrix correlations (Lorenzo-Seva and Ferrando, 2006), as MacLean *et al.* (2012) did in the case of the MEQ.

As a final general reflection, we would like to call attention to the fact that Psychopharmacology, and more specifically in the case of Psychopharmacology of psychedelic drugs, seems to be a unique subdiscipline of the psychological sciences in which it is common to publish results based on poorly psychometrically explored questionnaires. Most of the questionnaires used in psychedelic research, including two of the three analyzed in our study, are usually considered useful tools not on the basis of their psychometric properties, but simply because they seem to work empirically well. In that sense, the three questionnaires discussed here (MEQ, HRS, and ARCI) have been demonstrated in numerous studies to be sensitive for discriminating subjective effects among different substances (dos Santos *et al.,* 2011; Caudevilla-Gálligo *et al.,* 2012), and/or to show dose related effects (Griffiths *et al.,* 2011; dos Santos *et al.,* 2012). Despite this good empirical performance, in the absence of a suitable psychometric analysis, it is hard to find out if what is being measured are in fact valid and reliable constructs, or just theoretical concepts with attractive labels but without proper mathematical content.

In sum, what we propose in this paper is a preliminary factor structure for three of the most widely used rating scales in the Psychopharmacology of psychedelics, that may allow future researchers to measure the subjective effects of psychedelic drugs in a more confident and precise fashion.

## CONFLICT OF INTEREST

The authors declare that there are no conflicts of interest.

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## APPENDIX

### MEQ (Spanish version)

The number in parentheses corresponds with the numbers of the items of MacLean *et al.* (2012)

1. **Pérdida del sentido habitual del tiempo (2)**
2. **Sentimiento de asombro (5)**
3. **Sensación de que la experiencia no se puede describir con palabras (6)**
4. **Obtención de un conocimiento agudo y claro experimentado a un nivel intuitivo (9)**
5. **Sensación de que has experimentado eternidad o infinito (12)**
6. **Experiencia de uno o unidad con objetos y/o personas percibidas a tu alrededor (14)**
7. **Pérdida del sentido habitual del espacio (15)**
8. **Sentimientos de ternura y dulzura (18)**
9. **Certeza de encuentro con la realidad última (en el sentido de ser capaz de "saber" y "ver" lo que es auténticamente real) en algún momento de la sesión (22)**
10. **Sensación de que no le puedes hacer justicia a la experiencia describiéndola en palabras (23)**
11. **Pérdida de la conciencia habitual del lugar físico en el que estabas (29)**
12. **Sentimientos de paz y tranquilidad (30)**
13. **Sensación de estar fuera del tiempo, más allá del pasado o del futuro (34)**
14. **Liberación de las limitaciones del Yo y sentimiento de unidad o vinculación con aquello percibido como algo más grande que el propio Yo (35)**
15. **Sentimiento de altura espiritual (36)**

16. **Experiencia de lo esencial y conciencia pura (más allá del mundo de las sensaciones) (41)**
17. **Experiencia de éxtasis (43)**
18. **Intuición de que "todo es Uno" (47)**
19. **Sensación de estar en una dimensión sin límites espaciales (48)**
20. **Experiencia de unidad con relación a un mundo interior (54)**
21. **Sentimiento de veneración (55)**
22. **Experiencia de atemporalidad (65)**
23. **Convencimiento actual, al rememorar la experiencia, de que en ella encontraste la realidad última (p.ej. que "veías" y "sabías" lo que era verdaderamente real) (69)**
24. **Sensación de haber experimentado algo profundamente sagrado y santo (73)**
25. **Conciencia de vida o presencia viviente en todas las cosas (74)**
26. **Experiencia de fusión del Yo en un todo más amplio (77)**
27. **Sentimiento de temor reverencial (80)**
28. **Experiencia de unidad con la realidad última (83)**
29. **Sensación de que será difícil explicar la propia experiencia a alguien que no haya vivido algo similar (86)**
30. **Sentimientos de alegría o júbilo (87)**