The Measurement Invariance of Schizotypy in Europe

Eduardo Fonseca-Pedrero[1,2], Javier Ortuño-Sierra[1], Guillaume Sierro[3], Christina Daniel[4], Matteo Cella[5], Antonio Preti[6], Christine Mohr[3] and Oliver J. Mason[4]

[1]Department of Educational Sciences, University of La Rioja

[2] Prevention Program for Psychosis (P3), Spain

[3] Institute of Psychology, University of Lausanne, Switzerland

[4]Research Department of Clinical, Educational and Health Psychology, University College London, UK.

[5] Department of Psychology, Institute of Psychiatry, Psychology & Neuroscience, King's College London, UK.

[6]Center of Liaison Psychiatry and Psychosomatics, University Hospital, University of Cagliari, Italy, and Centro Medico Genneruxi, Cagliari, Italy.

Corresponding author:
Eduardo Fonseca-Pedrero
Department of Educational Sciences,
University of La Rioja
C/ Luis de Ulloa, s/n, Edificio VIVES
C.P: 26002, Logroño, La Rioja, Spain
Telephone: +34 941 299 309
Fax: +34 941 299 333
E-mail: eduardo.fonseca.pedrero@gmail.com

Abstract

The short version of the Oxford-Liverpool Inventory of Feelings and Experiences (sO-LIFE) is a widely used measure assessing schizotypy and psychosis proneness; however few studies have tested whether sO-LIFE scores are equivalent across countries. The main goal of the present study was to test the measurement equivalence of the sO-LIFE scores in a large sample of non-clinical adolescents and young adults from four countries (UK, Switzerland, Italy, and Spain) covering four languages (English, French, Italian, Spanish). The scores were all obtained from validated versions in their respective language. The sample comprised 4,190 participants (*M* = 20.87 years; *SD* = 3.71 years). The study of the dimensional structure, using confirmatory factor analysis , revealed that both three (i.e., Unusual Perceptual Experiences, Cognitive Disorganisation, Introvertive Anhedonia) and four-factor (i.e., Unusual Perceptual Experiences, Cognitive Disorganisation, Introvertive Anhedonia, and Impulsive Nonconformity) models fitted well to the data in each country. Multi-group confirmatory factor analysis showed that the three-factor model had partial strong measurement invariance across country. Several items were non-invariant across samples. Significant statistical differences in the mean scores of the s-OLIFE were found by country. The reliability of the sO-LIFE scores for all countries, estimated with Ordinal alpha, ranged from 0.75 to 0.87. These results provide new information about the cross-cultural structure of schizotypy phenotype and support the validity and utility of sO-LIFE as a measure of psychometric high risk for psychosis in cross-cultural research.

Keywords: Schizotypy; Schizotypal; Invariance; Equivalence; Cross-cultural; O-LIFE

Schizotypy is a latent personality organization that harbours the liability for psychosis and schizophrenia (Lenzenweger, 2010; Meehl, 1990). From a dimensional point of view, Claridge (1997) considers schizotypy to be distributed along a continuum (an extended psychosis phenotype) from a state of health to a state of illness. Under certain environmental conditions (e.g., trauma, cannabis, stress) schizotypy would translate into clinical symptoms and need for care (Linscott & van Os, 2013). At a developmental endpoint of this trajectory, schizotypy would potentially connect with a clinical outcome (e.g. schizophrenia-spectrum disorders). This complex construct aims to capture the expression of trait-like personality features from non-clinical and subclinical levels to full-blown psychosis (Kwapil & Barrantes-Vidal, 2015).

Empirical evidence indicates that individuals with high scores on schizotypy questionnaires are at heightened risk for later development of psychosis (Debbané et al., 2015). Such individuals show overlapping yet less severe deficits and impairments to those found in clinical and ultra-high risk samples (Cohen, Mohr, Ettinger, Chan, & Park, 2015; Ettinger, Meyhöfer, Steffens, Wagner, & Koutsouleris, 2014; Ettinger et al., 2015; Raine, 2006). They share the same demographic and environmental risk factors to those found in patients with psychosis (e.g., trauma, cannabis) (Linscott & van Os, 2013). Moreover, the psychometric high-risk schizotypy approach has shown clinical relevance in line with conventional interview-based high-risk approaches for psychosis (Barrantes-Vidal, Gross, et al., 2013; Cicero, Martin, Becker, Docherty, & Kerns, 2014). Moreover, schizotypy is a key factor in the search for etiological factors relevant for psychosis, and so helps identify individuals for whom intervention may help earlier (Barrantes-Vidal, Grant, & Kwapil, 2015). Early identification and treatment of such at-risk individuals may delay or prevent the onset of the clinical outcome. Assuming that this literature and knowledge is universally valid, we need psychometrically sound assessment tools that are validated between cultures and language versions (Fonseca-Pedrero, Fumero, et al., 2014).

To assess schizotypy, several self-report questionnaires have been developed with the aim of assessing variation in healthy trait schizotypy as well as the latent vulnerability to psychosis spectrum disorders (Mason, 2015). One of these instruments is the Oxford-Liverpool Inventory of Feelings and Experiences (O-LIFE) (Mason, Claridge, & Jackson, 1995), or its short version (sO-LIFE) (Mason, Linney, & Claridge, 2005). The sO-LIFE is a brief self-report questionnaire comprising 43 items (Yes/No

response format) and four subscales that were psychometrically derived. The subscales are respectively positive schizotypy (i.e., Unusual Perceptual Experiences), Cognitive Disorganisation, negative schizotypy (i.e., Introvertive Anhedonia), and Impulsive Nonconformity. The first three subscales reflect on symptom dimensions reported from patients with schizophrenia, i.e. positive symptoms, negative symptoms and disorganised symptoms (Arndt, Alliger, & Andreasen, 1991; Liddle, 1987). Specifically, the psychometric properties has been firmly established for both the O-LIFE (Barragan, Laurens, Navarro, & Obiols, 2011; Burch, Steel, & Hemsley, 1998; Cochrane, Petch, & Pickering, 2010; Mason & Claridge, 2006) and sO-LIFE (Cella et al., 2013; Lin et al., 2013; Mason et al., 2005; Sierro, Rossier, Mason, & Mohr, in press).

Previous confirmatory factorial models on sO-LIFE data have demonstrated that the three-factor model (without Impulsive Nonconformity) fitted well to the data (Cella et al., 2013; Lin et al., 2013; Sierro et al., in press). Moreover, other studies have found adequate goodness-of-fit indices for the four-factor model in comparison with the competing models (Sierro et al., in press). From a clinical and psychometric point of view, several limitations have been found regarding the Impulsive Nonconformity dimension. For example, Linn and colleagues (2013), in a high risk sample, found a lack of internal consistency and factorial validity for the Impulsive Nonconformity dimension; moreover, this schizotypy dimension has not been found consistently in independent psychometric studies on schizotypy questionnaires (Kwapil, 1996).

The previous literature asks for further work to establish the structure of the sO-LIFE. Likewise, there has been no in-depth examination about the question of whether the structure underlying the schizotypy construct, through the sO-LIFE, is equivalent across different cultures (and by inference different languages). Yet, this equivalence is warranted if we assume that the schizotypy concept is sensitive to psychosis risk, and that psychosis risk is a universal phenomenon. Kwapil et al. (2012) argued that comparable dimensional structures in cross-cultural samples would lend further support to the i) continuum model of schizotypy and schizophrenia spectrum disorders and ii) validity and utility of these measures in cross-cultural research. Cohen et al. (2015) suggested that schizotypy assessed in different cultures has the potential to provide us with information on cultural differences in social and affective functioning. At the moment, few studies have been conducted to test the cross-cultural equivalence of the

schizotypal personality traits (Fonseca-Pedrero, Compton, et al., 2014; Ortuño-Sierra et al., 2013) and schizotypy dimensions (Kwapil et al., 2012; Sierro et al., in press). For instance, Sierro et al. (in press) have found measurement invariance of the factor structure of the sO-LIFE in two large samples of English and Swiss (French-speaking) nonclinical young adults.

In the current study, we examined the cross-cultural invariance of the factor structure of the sO-LIFE scores in a large sample of adolescents and nonclinical young adults from four countries (UK, Switzerland, Italy, and Spain) using data from four different language versions (English, French, Italian, Spanish). The study a) examined the dimensional structure of the sO-LIFE scores using CFAs in the four samples; b) tested the measurement invariance of the sO-LIFE scores across the four samples; c) compared latent mean and raw scores of the sO-LIFE across the four samples; and d) estimated the Ordinal alpha of the sO-LIFE scores and the accuracy for each country, using the Item Response Theory (IRT) framework. We hypothesized that the three-factor model would be more adequate than the other competing dimensional models. In addition, we further hypothesized that the dimensional structure of the sO-LIFE would be equivalent across countries, and raw scores would differ between countries. Finally, we expected that the reliability estimation and accuracy of the sO-LIFE scores would be adequate across samples.

Method

Participants

The overall sample consisted of 4190 (1524 male, 36.4%) students from the UK, the French-speaking part of Switzerland, Italy, and Spain. The mean age was 20.87 years (*SD* = 3.71), ranging from 15 to 35 years. Previous data of this sample have been published elsewhere (Cella et al., 2013; Sierro et al., in press).

The UK sample comprised 1117 English-speaking participants (439 male). Their mean age was 23.54 years (*SD* = 3.71), ranging from 18 to 35 years. They were not exclusively student-based, but had been predominantly recruited via London-based Universities. The French-speaking Swiss university students (*n* = 1,048; mean age 21.31 years; *SD* = 2.29; 18–30 years-old, 311 male) completed the French sO-LIFE online. They were recruited during psychology courses at two local Universities (University of Lausanne, école polytechnique fédérale de Lausanne). The Italian sample comprised

1023 students (mean age 17.3 years; *SD*= 1.3, 15 to 24 years, 506 males) who had fully completed the sO-LIFE. They had followed an invitation that was sent to all students enrolled in the three final years (i.e. III, IV and V) of four large high schools in the district of Cagliari, the main town (about 300,000 inhabitants) of Sardinia. Finally, the Spanish sample consisted of a total of 1002 university students (268 male, mean age 21.11 years, *SD* = 3.92, 17 to 35 years) recruited from several courses at The University of La Rioja.

Comparison of the four subsamples yielded statistically significant differences according to age ($F_{(3, 4189)} = 816.29$; $p < 0.001$) and gender ($\chi^2 = 140.31$; $p < 0.001$). All participants provided written informed consent prior to participation. The study was conducted in accordance with the guidelines of the Declaration of Helsinki (World Medical Association, 2013)

Instrument

Oxford-Liverpool Inventory of Feelings and Experiences short version (sO-LIFE) (Mason et al., 2005). The 43-item sO-LIFE (yes/no format) assesses positive schizotypy (12 Unusual Experiences items, e.g., ‘‘Are your thoughts sometimes so strong that you can almost hear them?’’), negative schizotypy (10 Introvertive Anhedonia items, e.g., ‘‘Do you prefer watching television to going out with people?’’), Cognitive Disorganization (11 items, e.g., ‘‘Are you easily confused if too much happens at the same time?’’), and Impulsive Nonconformity (10 items, e.g., ‘‘Do you at times have an urge to do something harmful or shocking?’’). Previous studies using the sO-LIFE showed that this measure is psychometrically reliable and valid (Cella et al., 2013; Sierro et al., in press) (Barrantes-Vidal, Gómez-de-Regil, et al., 2013). The sO-LIFE was adapted into Spanish, French, and Italian following the international guidelines for test adaptation (Muñiz, Elosua, & Hambleton, 2013).

Procedure

Participants from Spanish and Italian sample completed the measurement instrument in a group session (10 to 50 students), during a standard hour-long class. Participants were informed about the research and, signed an informed consent. They did not receive incentives for taking part in the study. Administration of the instruments was always under the supervision of a researcher.

Data analyses

First, based on previous literature, we tested different hypothetical dimensional models by means of CFAs. Due to the categorical nature of the data, we used the Weighted Least Squares Means and Variance adjusted (WLSMV) estimator. In Model 1 we sought to test whether the 43 items loaded on a unidimensional latent structure. In Model 2 we tested three correlated latent factors (Positive, Negative, and Cognitive Disorganization). In Model 3, we tested four correlated latent factors (Positive, Negative, Cognitive Disorganization, and Impulsive Nonconformity). The goodness-of-fit indices employed were: chi-square; the Comparative Fit Index (CFI), the Tucker-Lewis Index (TLI), the Root Mean Square Error of Approximation (RMSEA) (and 90% confidence interval), and Weighted Root Mean Square Residual (WRMR). To achieve a good fit of the data to the model, the values of CFI and TLI should be over 0.95, and the RMSEA values should be under 0.08 for a reasonable fit and under 0.05 for a good fit (Hu & Bentler, 1999). For the WRMR values, a value below 1.0 has been suggested as indicative of adequate model fit.

Second,, we tested measurement invariance using successive multi-group CFAs (Byrne, 2008; Meredith, 1993). This is a hierarchical set of steps that involves that measurement invariance is tested first, typically starting with the determination of a well-fitting multi-group baseline model. The set continues with the establishment of successive equivalence constraints in the model parameters across groups. The analysed dimensional models can be seen as nested models to which constraints are progressively added. Using Delta parameterization in Mplus, two steps on measuring invariance need to be considered: Configural and strong invariance models (Muthén & Asparouhov, 2002). In the first step we established the configural invariance model, in which items were constrained to load on the same factors across groups, but all item thresholds and factor loadings were free to vary across groups. In a second step we established a strong invariance model, which contained cross-group equality constraints on all factor loadings and item thresholds. Furthermore, factor means fixed to zero in the first group and free in the other groups and scale factors fixed to one in the first group and free in the other groups.

Due to the limitations of the $\Delta\chi^2$ regarding its sensitivity to sample size, Cheung and Rensvold (2002) proposed a more practical criterion, the change in CFI (ΔCFI), to

determine if nested models are practically equivalent. In this study, when ΔCFI is greater than 0.01 between two nested models, the more constrained model is rejected since the additional constraints have produced worse fit. However, if the change in CFI is less than or equal to 0.01, it is considered that all specified equal constraints are tenable, and therefore, it is possible to continue with the next step in the analysis of measurement invariance. However, when this criterion is not met and some of the parameters (e.g., factorial loadings) are not specified to be equal across groups, partial measurement invariance can be considered (Byrne, Shavelson, & Muthén, 1989).

Third, we subsequently analysed the raw scores of the sO-LIFE subscales between groups using a multivariate analysis of covariance. Gender and age were considered as covariables and country as fixed factor. As an index of effect size, partial eta square (partial η^2) was employed.

Finally, once the different measurement models were tested, we calculated the internal consistency of the sO-LIFE scores in each country. To obtain a measure of the reliability of the scores, we calculated Ordinal alpha coefficients for Likert data. Ordinal alpha is conceptually equivalent to Cronbach's alpha and it performs well for dichotomous data (Zumbo, Gadermann, & Zeisser, 2007). To the best of our knowledge no other studies have study the internal consistency of the sO-LIFE through Ordinal alpha. Thus, and taking into account the categorical nature of the s-O-LIFE items, new studies that further extend the knowledge of the reliability of the scores through Ordinal alpha are still needed. . Furthermore, the information function of the total score for each sample and schizotypy dimension was estimated. The information function is an extension of the precision of measurement in Classical Test Theory (CTT), within IRT framework (Reise & Waller, 2009). It allows estimating the contribution of each item or dimension to the assessment of each level of the latent construct or theta (e.g., schizotypy). Theta score is measured on interval scale (M=0; variance=1). Within the CTT framework, the precision is uniform across the entire range of the test scores; however, test information functions are related to the measurement precision (or standard error of measurement) and show the degree of precision at different levels of theta or latent trait. A value of test information around 4 is equivalent to a reliability coefficient of .80

SPSS 15.0 (Statistical Package for the Social Sciences, 2006), FACTOR 9.2 (Lorenzo-Seva & Ferrando, 2013), and Mplus 7.1 (Muthén & Muthén, 1998-2012) were used for data analyses.

Results

Confirmatory factor analysis of the sO-LIFE scores

Table 1 shows the goodness-of-fit indices for the dimensional models tested in each country. As can be seen in Table 1, the three and four-factor model showed adequate goodness-of-fit indices. In fact, the three-factor model showed the best goodness-of-fit indices in comparison with other competing models, however in several countries the goodness-of-fit indices were close to the standards cut-offs. In this sense, we allowed several correlated error terms. For three samples (except Spain) modification indices were found on covariance uniqueness. The correlation between errors was made between those items that have similar content. In all samples, the goodness-of-fit model for the three factor model improved after the covariance uniqueness had been added (see Table 1). The following error terms were added: UK (error terms of items 10-6, 40-6, 9-34 and 10-40), Switzerland (error terms of items 23-6 and 15-16), and Italy (error terms of items 38-10, 8-34, and 28-31). We have added the covariance of uniqueness in these countries because there was a large misfit in those parameters.

The factor loadings for the final three-factor model were high and all statistically significant in each country, except for two items in the Italian sample. Based on previous models of schizotypy and higher goodness-of-fit indices, we chose the three factor model (with modifications) to be more adequate to test measurement invariance across countries.

----------Insert Table 1 around here ----------

Measurement invariance of the sO-LIFE scores across country

Given that the three-factor model evidenced the best fit, we next tested the measurement equivalence of this model across countries. Prior to the analysis of measurement invariance, we tested whether this model showed a reasonable good fit to the data in each group separately (see Table 1). As can be seen in Table 2, the configural invariance model in which no equality constraints were imposed showed an

adequate fit to the data. The strong invariance model was then tested with the factor loadings and threshold constrained to be equal across groups. The ΔCFI between the constrained and the unconstrained model was higher than 0.01, indicating that item factor loadings and threshold invariance was not supported. Several thresholds and factor loadings were relaxed (items 10, 12, 25, 29, 31, 33, 39, and 43), meaning that these thresholds and factor loadings were non-equivalent across countries. After these parameters were freed the model fit was adequate. Thresholds and loadings were different between countries. The ΔCFI between the constrained and the unconstrained model was under 0.01, indicating that partial strong measurement invariance by gender was supported.

----------Insert Table 2 about here ----------

Mean scores comparison of the sO-LIFE subscales by gender and country

Table 3 shows the descriptive statistics referring to the means and standard deviations for each sample on the sO-LIFE subscales. Before the effect of country was tested, we analyzed the effect of gender on the s-OLIFE scores. Mean comparison by gender showed statistically significant differences in all sO-LIFE subscales: Positive schizotypy (M (SD) $_{male}$= 3.18 (2.50), M (SD) $_{female}$=3.39 (2.63); t= -2.578; p<0.01; d= 0.08), Cognitive Disorganisation (M (SD) $_{male}$= 4.24 (1.79); M (SD) $_{female}$= 4.93 (2.81); t=-7.803; p<0.01; d= 0.28), Introvertive Anhedonia (M (SD) $_{male}$= 2.41 (2.04); M (SD) $_{female}$= 1.85 (1.56); t=10.366; p<0.01; d= 0.33), and Impulsive Nonconformity (M (SD) $_{male}$= 3.34 (2.04); M (SD) $_{female}$= 3.08 (2.05); t=3.843; p<0.01; d= 0.13).

The multivariate analysis of covariance revealed statistically significant differences according to age (Wilk´s λ= 0.993, $F_{(4, 4181)}$ = 7.645; p < 0.001), gender (Wilk´s λ= 0.954, $F_{(4, 4181)}$ = 50.366; p < 0.001), and country (Wilk´s λ= 0.840, $F_{(12, 11062)}$ = 62.891; p < 0.001). As can be seen in Table 3, a significant main effect of country on mean scores of the sO-LIFE subscales was found.

----------Insert Table 3 around here ----------

Reliability estimation and accuracy of the sO-LIFE scores

Table 4 shows the ordinal alpha values for the sO-LIFE subscales and samples. The ordinal alpha estimations ranged between 0.75 and 0.87 for the sO-LIFE subscales in each country. According to IRT, the study of measurement precision indicated that all information functions provide optimal estimations (for each country and sO-LIFE subscale) in participants with medium and high latent-trait values for each schizotypy dimension (see Figures 1, 2, 3, and 4). For example, the information function of the Positive schizotypy dimension provided maximum information at the +1 level of latent trait. Moreover, information curves for each schizotypy dimension are quite similar across countries with slight differences. For instance, as it can be seen in Figures 1, 2, 3 and 4, the amount of test information in the Spanish Sample with Anhedonia Introvertive dimension is bigger than other countries in the value of latent trait of +2.

----------Insert Table 4 and Figures 1, 2, 3, and 4 about here ----------

Conclusions

There has been no in-depth examination about the question of whether the dimensional structure underlying the schizotypy construct, through the sO-LIFE, is equivalent across a number of different countries. The main goal of this study was to test the cross-cultural invariance of the factor structure of the sO-LIFE scores in four large samples of English, French (Switzerland), Italian, and Spanish speaking non-clinical adolescents and young adults. To this end, we analyzed the internal structure of the sO-LIFE scores using CFAs. In addition, we tested the invariance of the three factor schizotypy model across countries. We also compared the raw scores of the schizotypy dimensions, estimated the reliability of the scores with Ordinal alpha and accuracy for the sO-LIFE dimensions across countries using the IRT framework. Kwapil et al. (2012) argued that comparable factorial structures in cross-cultural studies would lend further support to the i) continuum model of schizotypy and schizophrenia spectrum disorders and ii) validity and utility of these measures in cross-cultural research. Moreover, Cohen et al. (2015) suggested that schizotypy assessed in different cultures has the potential to provide us with information on cultural differences in social and affective functioning.

The analysis of the dimensional structure of sO-LIFE scores showed that the three-factor model of schizotypy, composed of Unusual Perceptual Experiences, Cognitive Disorganisation, and Introvertive Anhedonia, fitted well to the data in each country; however, it is worth mentioning, that adequate goodness-of-fit indices were found after different correlated error were added in some countries. The inclusion of the Impulsive Nonconformity dimension, four-factor model, displayed lower goodness-of-fit indices than the three-factor model. In relation to the consistency of the Impulsive Nonconformity facet similar results have been found. For example, Linn et al. (2013), in a sample of individuals at high risk for psychosis, found a lack of consistency for the Impulsive Nonconformity dimension. It is worth noting that the decision of whether or not to include Impulsive Nonconformity dimension should rely on theoretical grounds (i.e., definition of schizotypy) and research goals (Mason & Claridge, 2006; Sierro et al., in press). However, the data presented in this study favour the use of the three-factor model as this seems to provide a better representation of the dimensional structure underlying the sO-LIFE.

Multigroup CFAs showed that the three-factor model of the sO-LIFE had partial measurement invariance across countries. In this sense, several non-invariant items were found across. These results point to a measurement bias and inform that eight items are non-equivalent across countries. Another possibility, of the presence of these non-invariant items, is that differences are rooted in the complexity of the tested factor model, the psychometric properties of the tool, the method of assessment (e.g., self-report instruments) or sampling bias. Similar results have been found in previous works (Fonseca-Pedrero, Compton, et al., 2014; Kwapil et al., 2012; Ortuño-Sierra et al., 2013). For instance, in the study by Fonseca-Pedrero et al. (2014), the cross-cultural invariance of the factor structure of the Schizoytpal Personality Questionnaire (SPQ) (Raine, 1991) was examined in two large samples of Spanish and American young adults. Their results supported configural, metric, and partial measurement invariance of the covariances of the SPQ scores across countries. It should be stressed that if measurement invariance does not hold, the validity of such scores should be questioned. The comparability between different groups only makes sense if it can be guaranteed that participants interpret and understand the latent construct in a similar manner (Byrne, 2008; Meredith, 1993).

Significant statistical differences in the mean scores, controlling for gender and age, were found between countries. The Spanish sample as compared to other countries scored lower on Unusual Perceptual, Introvertive Anhedonia, and Impulsive Nonconformity dimensions. Compared to other countries, the English sample scored higher on Impulsive Nonconformity dimension. The Swiss sample as compared to Spanish and Italian samples scored higher on Cognitive Disorganisation dimension. Compared to the other countries, the Italian sample scored higher on the Introvertive Anhedonia and lower in Cognitive Disorganisation dimension. In some cases the effect sizes, estimated with partial eta squared, were small. Kwapil et al. (2012) obtained similar results using the Chapman's Scales; American students scored higher than Spaniards on both positive and negative dimensions of schizotypy. In another study, Fonseca-Pedrero et al. (2014) found that American participants obtained higher SPQ scores on average across all schizotypy dimensions than did the Spaniards except for Social Anxiety domain. Studies comparing mean schizotypy dimension scores between members of different racial/ethnic groups have also yielded similar results. Chmielewski et al. (1995) found that African-American students scored significantly higher on positive and negative schizotypy than did Caucasian students. Similar results have been found investigating psychotic-like experiences or psychotic symptoms (Johns, Nazroo, Bebbington, & Kuipers, 2002; Larøi et al., 2014; Nuevo et al., 2012). For example, Johns et al. (2002) reported that hallucinations varied significantly between ethnic groups, with the highest rates in Caribbean individuals and the lowest in individuals who identify as South Asian. In this sense, culture does indeed have a significant impact on the experience, understanding, and labelling of several psychotic-like experiences (i.e., hallucinations) and that there may be important theoretical and clinical consequences at different levels (Cohen et al., 2015; Larøi et al., 2014). These cross-cultural findings could be of crucial relevance in psychosis and early detection and prevention research. For instance, they could be of value for determining cut-off points for detecting participants at risk for psychosis in the context of a given culture (Fonseca-Pedrero, Compton, et al., 2014).

The reliability of the sO-LIFE scores, estimated with ordinal alpha, were above 0.75. These levels of internal consistency were adequate and are in line with the internal consistency values reported in previous studies. Previous work using ordinal alpha have found good reliability estimates (Lin et al., 2013; Sierro et al., in press) but others using

Guttman's *lambda2* did not (Cella et al., 2013). Within IRT framework, a novel approach to study the precision of the schizotypy scores, the sO-LIFE's subscales provide more accuracy information at the medium and high end of the latent trait (i.e., Positive schizotypy). These result are interesting as individuals with higher schizotypy scores (i.e., theoretically more risk) obtain more precise estimations (less error of measurement) and with more information as compared to those individuals who obtain low scores on the latent trait (Fonseca-Pedrero, Menéndez, Paino, Lemos-Girádez, & Muñiz, 2013; Fonseca-Pedrero, Paino, Santarén-Rosell, Lemos-Giráldez, & Muñiz, 2012). This point might be relevant in order to improve our accuracy in detecting individuals at-high risk for psychosis. If the main goal is to identify individuals' at-high risk for psychotic spectrum disorders, then measuring instruments with adequate psychometric properties are crucial, and studies examining their psychometric quality across different measuring approaches and samples are necessary.

The results reveal that the sO-LIFE scores showed adequate psychometric properties across countries and hold implications for the use of this tool in cross-cultural research. Likewise, the findings have helped to improve our understanding of subclinical psychosis phenotype as well as in order to understand the expression of the liability of psychosis at subclinical level in samples of general population and across countries. The results of the present study should be interpreted in the light of the following limitations. First of all, the participants were largely university students and this fact precludes the generalization of the results to other populations of interest. Secondly, the study is subject to the problems inherent to any research based on self-reports, and future studies in this context should consider the use of external informants or interviews. Thirdly, we did not use an infrequency response scale in order to detect those participants that displayed random or pseudo-random patterns of responses.

The current results provide new possibilities in schizotypy research, i.e. the use of schizotypy questionnaires in a cross-cultural context, whether the target populations are of clinical interest or whether variance of behaviour in the healthy population is considered. Future studies should look deeper into the analysis of schizotypy and psychosis screening measures across cultures and share data in big-data projects.

References

Arndt, S., Alliger, R. J., & Andreasen, N. C. (1991). The distinction of positive and negative symptoms. The failure of a two-dimensional model. *British Journal of Psychiatry, 158*, 317-322.

Barragan, M., Laurens, K. R., Navarro, J. B., & Obiols, J. E. (2011). Psychotic-like experiences and depressive symptoms in a community sample of adolescents. *European Psychiatry, 26*, 396-401.

Barrantes-Vidal, N., Gómez-de-Regil, L., Navarro, B., Vicens-Vilanova, J., Obiols, J., & Kwapil, T. (2013). Psychotic-like symptoms and positive schizotypy are associated with mixed and ambiguous handedness in an adolescent community sample. *Psychiatry Research, 206*, 188-194.

Barrantes-Vidal, N., Grant, P., & Kwapil, T. (2015). The role of schizotypy in the study of the etiology of schizophrenia spectrum disorders. *Schizophrenia Bulletin, 41*, S408-416.

Barrantes-Vidal, N., Gross, G., Sheinbaum, T., Mitjavila, M., Ballespí, S., & Kwapil, T. R. (2013). Positive and negative schizotypy are associated with prodromal and schizophrenia-spectrum symptoms. *Schizophrenia Research, 145*, 50-55.

Burch, G. S. J., Steel, C., & Hemsley, D. R. (1998). Oxford-Liverpool Inventory of Feelings and Experiences: Reliability in an experimental population. *British Journal of Clinical Psychology, 37*(1), 107-108.

Byrne, B. (2008). Testing for multigroup equivalence of a measuring instrument: A walk through the process. *Psicothema, 20*, 872-882.

Byrne, B. M., Shavelson, R. J., & Muthén, B. (1989). Testing for the equivalence of factor covariance and mean structures: The issue of partial measurement invariance. *Psychological Bulletin, 105*, 456-466.

Cella, M., Serra, M., Lai, A., Mason, O. J., Sisti, D., Rocchi, M. B., . . . Petretto, D. R. (2013). Schizotypal traits in adolescents: Links to family history of psychosis and psychological distress. *European Psychiatry, 28*, 247-253.

Cicero, D. C., Martin, E. A., Becker, T. M., Docherty, A. R., & Kerns, J. G. (2014). Correspondence between psychometric and clinical high risk for psychosis in an undergraduate population. *Psychological Assessment*.

Claridge, G. (1997). *Schizotypy: Implications for illness and health*. Oxford: Oxford University Press.

Cochrane, M., Petch, I., & Pickering, A. D. (2010). Do measures of schizotypal personality provide non-clinical analogues of schizophrenic symptomatology? *Psychiatry Research, 176*, 150-154.

Cohen, A., Mohr, C., Ettinger, U., Chan, R. C. K., & Park, S. (2015). Schizotypy as an organizing framework for social and affective sciences. *Schizophrenia Bulletin, 41*, S427-435.

Cheung, G. W., & Rensvold, R. B. (2002). Evaluating goodness-of-fit indexes for testing measurement invariance. *Structural Equation Modeling, 9*(2), 233-255.

Chmielewski, M., Fernandes, L. O., Yee, C. M., & Miller, G. A. (1995). Ethnicity and gender in scales of psychosis proneness and mood disorders. *Journal of Abnormal Psychology, 104*, 464-470.

Debbané, M., Eliez, S., Badoud, D., Conus, P., Flückiger, R., & Schultze-Lutter, F. (2015). Developing psychosis and its risk states through the lens of schizotypy. *Schizophrenia Bulletin, 41*, S396-407.

Ettinger, U., Meyhöfer, I., Steffens, M., Wagner, M., & Koutsouleris, N. (2014). Genetics, cognition, and neurobiology of schizotypal personality: a review of the overlap with schizophrenia. *Frontiers of Psychiatry, 5*, 18.

Ettinger, U., Mohr, C., Gooding, D., Cohen, A., Rapp, A., Haenschel, C., & Park, S. (2015). Cognition and brain function in schizotypy: A selective review. *Schizophrenia Bulletin, 41*, S417-426.

Fonseca-Pedrero, E., Compton, M., Tone, E. B., Ortuño-Sierra, J., Paino, M., Fumero A., & Lemos-Girádez, S. (2014). Cross-cultural invariance of the factor structure

of the Schizotypal Personality Questionnaire across Spanish and American college students. *Psychiatry Research, 30,* 1071-1076.

Fonseca-Pedrero, E., Fumero, A., Paino, M., de Miguel, A., Ortuño-Sierra, J., Lemos Giraldez, S., & Muñiz, J. (2014). Schizotypal Personality Questionnaire: New sources of validity evidence in college students. *Psychiatry Research, 219*, 214-220.

Fonseca-Pedrero, E., Menéndez, L. F., Paino, M., Lemos-Girádez, S., & Muñiz, J. (2013). Development of a computerized adaptive test for schizotypy assessment. *PLoS One, 8* (9), e73201

Fonseca-Pedrero, E., Paino, M., Santarén-Rosell, M., Lemos-Giráldez, S., & Muñiz, J. (2012). Psychometric properties of the Peters et al Delusions Inventory 21 in college students. *Comprehensive Psychiatry, 53*, 893-899.

Hu, L.-T., & Bentler, P. M. (1999). Cut off criteria for fit indexes in covariance structure analysis: Conventional criteria versus new alternatives. *Structural Equation Modeling, 6,* 1-55.

Johns, L. C., Nazroo, J. Y., Bebbington, P., & Kuipers, E. (2002). Ocurrence of hallucinatory experiences in a community sample and ethnic variations. *British Journal of Psychiatry, 180,* 174-178.

Kwapil, T. R. (1996). A longitudinal study of drug and alcohol use by psychosis-prone and impulsive-nonconforming individuals. *Journal of Abnormal Psychology, 105*, 114-123.

Kwapil, T. R., & Barrantes-Vidal, N. (2015). Schizotypy: Looking back and moving forward. *Schizophrenia Bulletin, 41*, S366-373.

Kwapil, T. R., Ros-Morente, A., Silvia, P. J., & Barrantes-Vidal, N. (2012). Factor invariance of psychometric schizotypy in Spanish and American samples. *Journal of Psychopathology and Behavioral Assessment, 34*, 145–152.

Larøi, F., Luhrmann, T. M., Bell, V., Christian, W. A. J., Deshpande, S., Fernyhough, C., . . . Woods, A. (2014). Culture and hallucinations: overview and future directions. *Schizophrenia Bulletin, 40*, S213-220.

Lenzenweger, M. F. (2010). Current status of the scientific study of the personality disorders: an overview of epidemiological, longitudinal, experimental psychopathology, and neurobehavioral perspectives. *Journal of the American Psychoanalytic Association, 58*, 741-778.

Liddle, P. (1987). The symptoms of chronic schizophrenia: A re-examination of the positive-negative dichotomy. *British Journal of Psychiatry, 151*, 145-151.

Lin, A., Wigman, J. T., Nelson, B., Wood, S. J., Vollebergh, W. A., van Os, J., & Yung, A. R. (2013). Follow-up factor structure of schizotypy and its clinical associations in a help-seeking sample meeting ultra-high risk for psychosis criteria at baseline. *Comprehensive Psychiatry, 54*, 173-180.

Linscott, R. J., & van Os, J. (2013). An updated and conservative systematic review and meta-analysis of epidemiological evidence on psychotic experiences in children and adults: on the pathway from proneness to persistence to dimensional expression across mental disorders. *Psychological Medicine, 43*, 1133-1149.

Lorenzo-Seva, U., & Ferrando, P. J. (2013). FACTOR 9.2: A comprehensive program for fitting exploratory and semiconfirmatory factor analysis and IRT models. *Applied Psychological Measurement, 37*, 497-498.

Mason, O. (2015). The assessment of schizotypy and its clinical relevance. *Schizophrenia Bulletin, 41*, S374-385.

Mason, O., & Claridge, G. (2006). The Oxford-Liverpool Inventory of Feelings and Experiences (O-LIFE): Further description and extended norms. *Schizophrenia Research, 82*(2), 203-211.

Mason, O., Claridge, G., & Jackson, M. (1995). New scales for the assessment of schizotypy. *Personality and Individual Differences, 18*, 7-13.

Mason, O., Linney, Y., & Claridge, G. (2005). Short scales for measuring schizotypy. *Schizophrenia Research, 78*(2), 293-296.

Meehl, P. E. (1990). Toward an integrated theory of schizotaxia, schizotypy, and schizophrenia. *Journal of Personality Disorders, 4*(1), 1-99.

Meredith, W. (1993). Measurement invariance, factor analysis and factorial invariance. *Psychometrika, 58*, 525-543.

Muñiz, J., Elosua, P., & Hambleton, R. K. (2013). Directrices para la traducción y adaptación de los tests: segunda edición [International Test Commission Guidelines for test translation and adaptation: Second edition]. *Psicothema, 25*, 151-157.

Muthén, B. O., & Asparouhov, T. (2002). Latent variable analysis with categorical outcomes: Multiple-group and growth modeling in Mplus. Mplus Web Note No. 4, at http://

www.statmodel.com/mplus/examples/webnote.html.

Muthén, L. K., & Muthén, B. O. (1998-2012). *Mplus User's Guide. Seventh Edition*

Los Angeles, CA: Muthén & Muthén.

Nuevo, R., Chatterji, S., Verdes, E., Naidoo, N., Arango, C., & Ayuso-Mateos, J. L. (2012). The continuum of psychotic symptoms in the general population: A cross-national study. *Schizophrenia Bulletin, 38*, 475-485.

Ortuño-Sierra, J., Badoud, D., Knecht, F., Paino, M., Eliez, S., Fonseca-Pedrero, E., & Debbané, M. (2013). Testing Measurement Invariance of the Schizotypal Personality Questionnaire-Brief Scores across Spanish and Swiss Adolescents. *PLoS One, 8*(12), e82041.

Raine, A. (1991). The SPQ: A scale for the assessment of schizotypal personality based on DSM-III-R criteria. *Schizophrenia Bulletin, 17*, 555-564.

Raine, A. (2006). Schizotypal personality: neurodevelopmental and psychosocial trajectories. *Annual Review of Clinical Psychology 2*, 291-326.

Reise, S. P., & Waller, N. G. (2009). Item response theory and clinical measurement. *Annual Review of Clinical Psychology, 5*, 27-48.

Sierro, G., Rossier, J., Mason, O., & Mohr, C. (in press). French Validation of the O-LIFE Short Questionnaire. *European of Psychological Assessment*.

Statistical Package for the Social Sciences. (2006). *SPSS Base 15.0 User's Guide*. Chicago, IL: SPSS Inc.

World Medical Association. (2013). World Medical Association Declaration of Helsinki: Ethical principles for medical research involving human subjects. *The Journal of the American Medical Association (JAMA), 310*, 2191-2194.

Zumbo, B. D., Gadermann, A. M., & Zeisser, C. (2007). Ordinal versions of coefficients alpha and theta for Likert rating scales. *Journal of Modern Applied Statistical Methods, 6*, 21-29.

Table 1

Goodness-of-fit indices resulting from the dimensional models tested in each country

Model	χ^2	*df*	CFI	TLI	RMSEA (90% CI)	WRMR
UK						
One-dimensional	3386.97	860	0.743	0.730	0.051 (0.049-0.053)	2.062
Three factors	1288.08	492	0.897	0.889	0.038 (0.036-0.041)	1.542
Three factors with CE	1150.84	488	0.914	0.907	0.035 (0.032-0.037)	1.446
Four factors	2405.25	854	0.842	0.883	0.040 (0.038-0.034)	1.708
Switzerland						
One-dimensional	2617.51	860	0.748	0.735	0.044 (0.042-0.046)	1.773
Three factors	1221.72	492	0.863	0.853	0.038 (0.035-0.040)	1.502
Three factors with CE	1161.55	490	0.874	0.864	0.036 (0.033-0.039)	1.459
Four factors	1941.47	854	0.844	0.833	0.035 (0.033-0.037)	1.498
Italy						
One-dimensional	1825.92	860	0.835	0.827	0.033(0.031-0.035)	1.459
Three factors	1005.17	492	0.873	0.864	0.032 (0.029-0.035)	1.365
Three factors with CE	909.17	489	0.897	0.888	0.029 (0.026-0.032)	1.282
Four factors	1589.71	854	0.874	0.867	0.029 (0.027-0.031)	1.336
Spain						
One-dimensional	1872.48	860	0.838	0.830	0.034 (0.032-0.036)	1.503
Three factors	938.45	492	0.908	0.901	0.030 (0.027-0.033)	1.229
Four factors	1496.63	854	0.897	0.891	0.027 (0.025-0.030)	1.301

Note. χ^2 = Chi-square; *df* = degrees of freedom; CFI = Comparative Fit Index; TLI = Tucker-Lewis Index; RMSEA = Root Mean Square Error of Approximation; CI = Confidence Interval; WRMR = Weighted Root Mean Square Residual; CE = Correlated errors.

Table 2

Goodness-of-fit indices of measurement invariance across country

Model	χ^2	*df*	CFI	TLI	RMSEA (90 % CI)	WRMR	ΔCFI
Configural invariance	4150.1	1959	0.900	0.893	0.033 (0.031-0.034)	2.748	
Strong invariance	5295.1	2040	0.852	0.847	0.039 (0.038-0.040)	3.250	+0.01
Partial strong invariance	4458.4	2016	0.890	0.884	0.034 (0.033-0.036)	2.920	-0.01

Note. χ^2 = Chi-square; *df* = Degrees of Freedom; CFI = Comparative Fit Index; TLI = Tucker-Lewis Index; RMSEA = Root Mean Square Error of Approximation; CI = Confidence Interval; WRMR = Weighted Root Mean Square Residual; ΔCFI = Change in Comparative Fix Index.

Table 3

Mean comparison by country (controlling for gender and age) for the sO-LIFE subscales

	UK		Switzerland		Italy		Spain					
sO-LIFE	*Mean*	*SD*	*Mean*	*SD*	*Mean*	*SD*	*Mean*	*SD*	*F*	*p*	*Partial* η^2	*Post hoc*
Unusual Experiences	3.48	2.76	3.73	2.59	3.72	2.49	2.32	2.21	72.884	<0.01	0.050	Sp < UK, Sw, It
Cognitive Disorganization	5.15	2.94	5.53	2.82	3.87	2.38	4.12	2.67	93.704	<0.01	0.063	UK > It, Sp; Sw> It, Sp; Sp>It
Introvertive Anhedonia	2.03	1.86	2.14	1.76	2.55	1.44	1.50	1.36	51.120	<0.01	0.035	UK < It, Sw; Sw > Uk, Sp; It > UK, Sw, Sp Sp < UK, Sw, It
Impulsive Nonconformity	3.59	2.11	3.04	2.04	3.48	2.05	2.55	1.81	55.608	<0.01	0.038	UK > Sw, It, Sp; Sw < Uk, It; It > Sw, Sp; Sp < Uk, Sw, It

Note. UK = United Kingdom; Sw = Switzerland; It = Italy, Sp = Spain.

Table 4

Ordinal alpha estimations for the sO-LIFE subscales

Country	Unusual Experiences	Cognitive Disorganization	Anhedonia Introvertide	Impulsive Nonconformity
UK	0.87	0.86	0.80	0.78
Switzerland	0.84	0.85	0.78	0.79
Italy	0.82	0.80	0.75	0.78
Spain	0.87	0.85	0.85	0.78

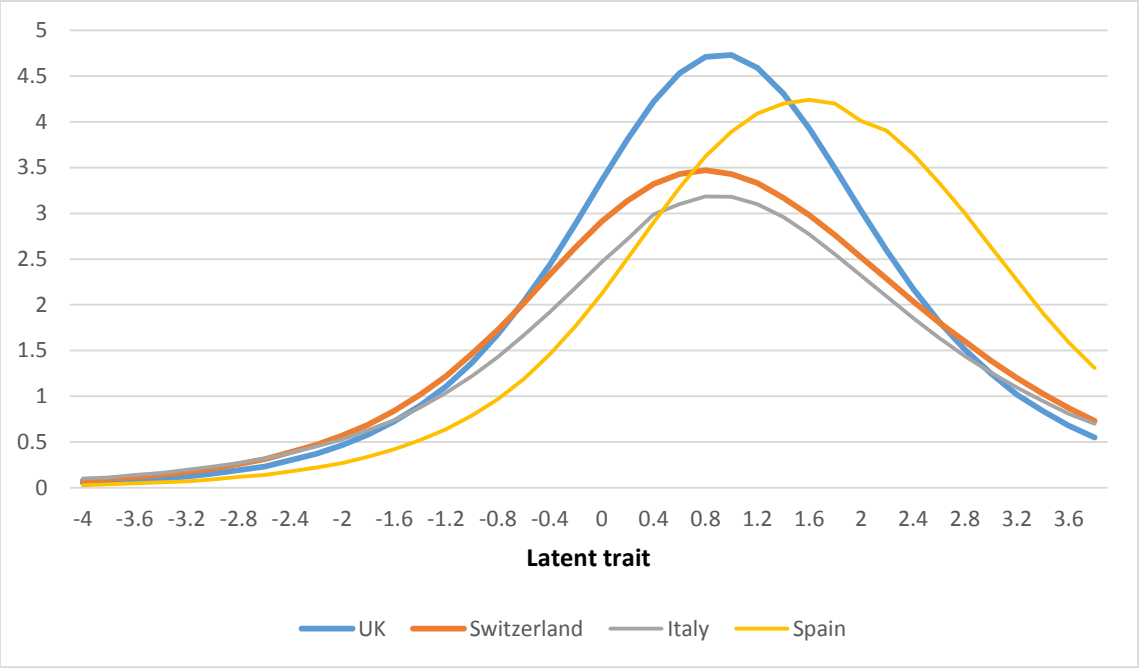

Figure 1. Information functions for the Unusual Perceptual Experiences dimension of the sO-LIFE across samples.

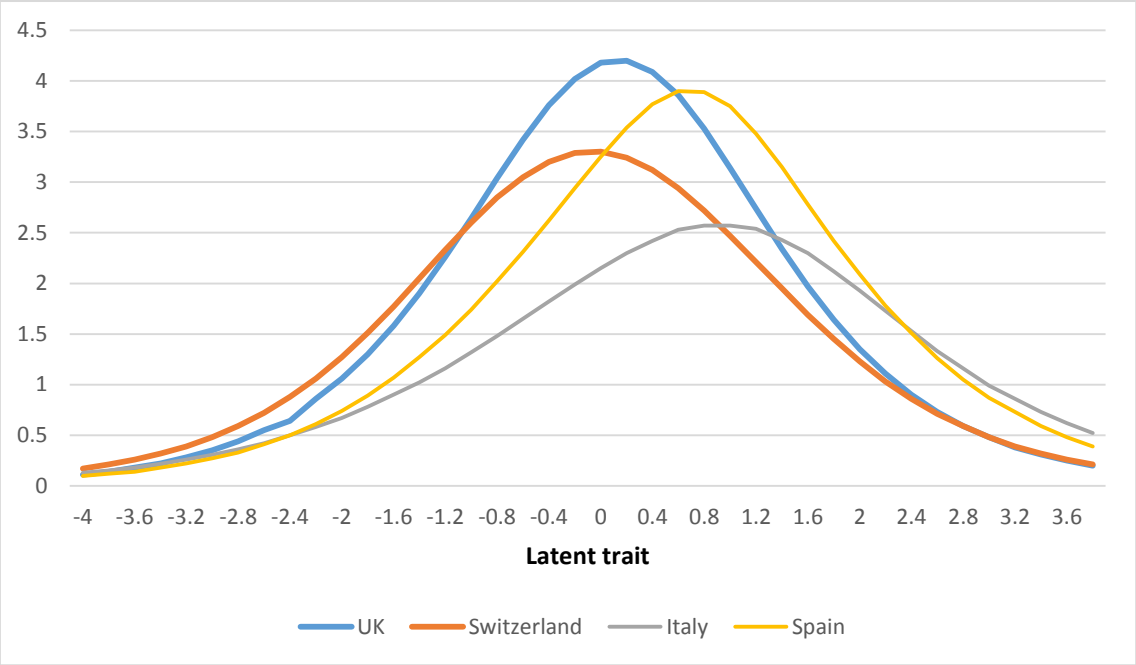

Figure 2. Information functions for the Cognitive Disorganization dimension of the sO-LIFE across samples.

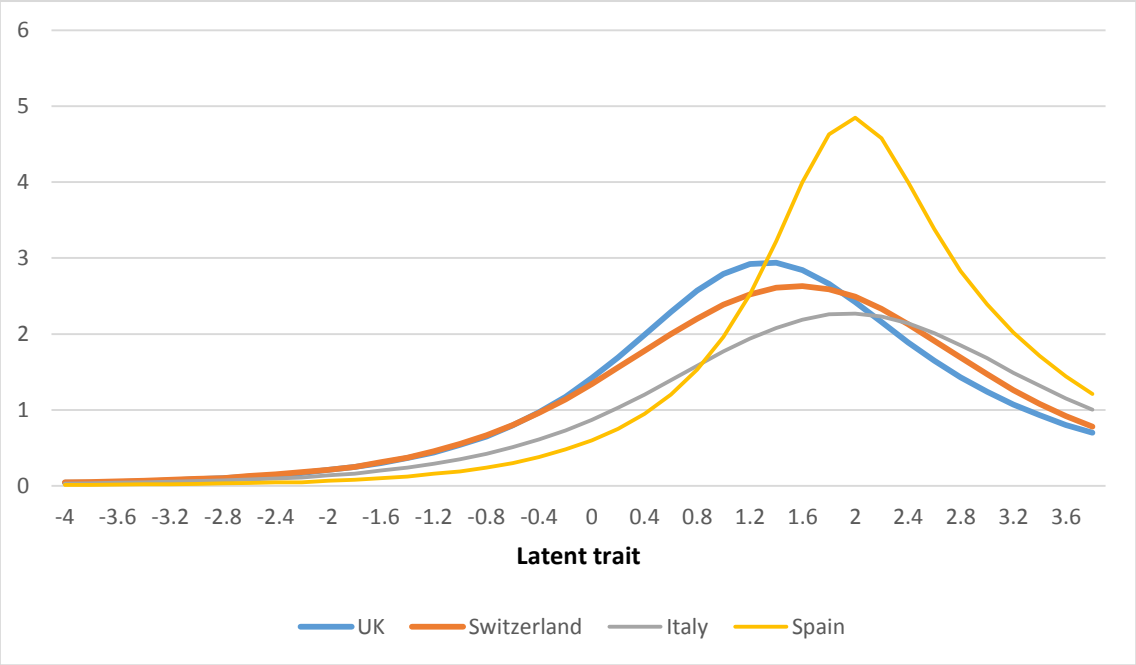

Figure 3. Information functions for the Introvertive Anhedonia dimension of the sO-LIFE across samples.

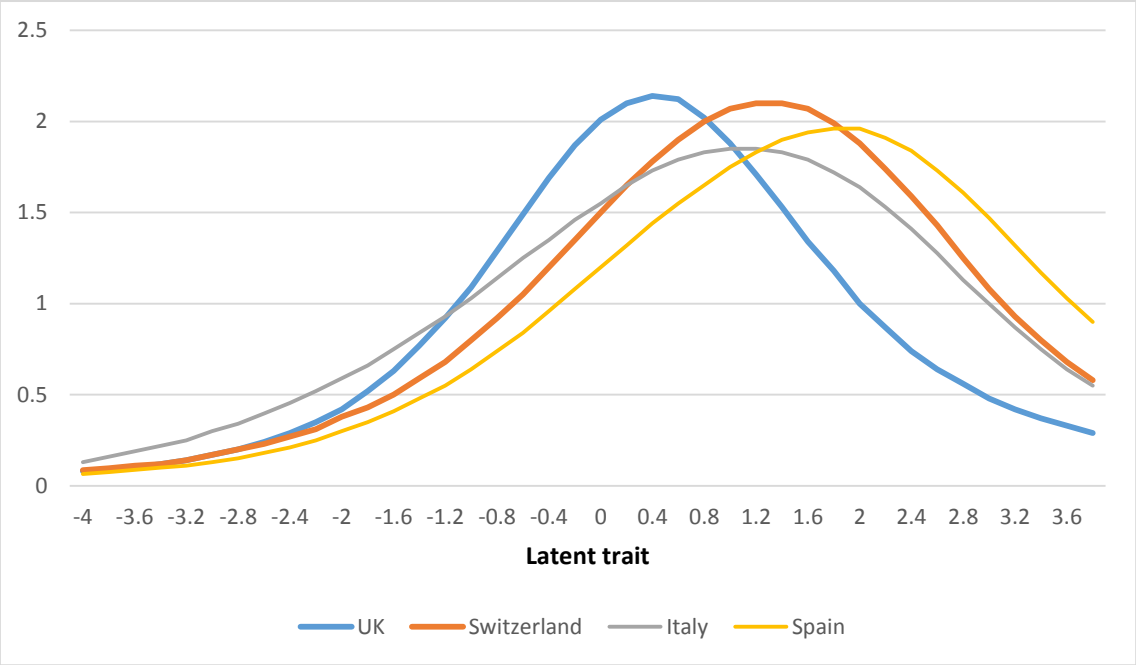

Figure 4. Information functions for the Impulsive Nonconformity dimension of the sO-LIFE across samples.