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The assessment of positive dimension of the psychosis phenotype in college students

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Abstract

The Wisconsin Schizotypy Scales are one of the most used measuring instruments for the assessment of psychometric risk for psychosis. The main goal of the present study was to analyze the reliability of the scores and to provide new sources of validity evidence for the brief version of the Magical Ideation Scale (MIS-B) and the Perceptual Aberration Scale (PAS-B). The final sample was comprised of a total of 1349 university students divided into two subsamples ($n1$ = 710; M = 19.8 years; $n2$ = 639; M = 21.2 years). Results show that both measurement instruments have adequate psychometric properties under Classical Test Theory and Item Response Theory. Internal structure analysis of MIS-B and PAS-B, through exploratory and confirmatory factor analysis, yielded an essentially one-dimensional solution. Cronbach's alpha coefficient for the total score of MIS-B ranged between 0.86 and 0.87, whereas for the PAS-B it ranged between 0.78 and 0.89. A total of 5 items showed a differential functioning for sex. The results indicate that the MIS-B and PAS-B are brief measurement instruments with adequate psychometric properties for the assessment of the positive dimension of the psychosis phenotype and could be used as screening tools in the detection of individuals at risk for psychosis in the general population.

1. Introduction

Schizotypy is a complex construct that is intimately related at historical, genetic, neurodevelopmental, neurocognitive, social, and psychophysiological levels to psychosis [1–4]. Independent follow-up studies indicate that individuals from the general population who report schizotypal experiences such as hallucinatory experiences and/or delusional ideation, have a greater risk of transitioning toward schizophrenia-spectrum disorders [5–10]. However, it is also true that recent studies indicate the low specificity of these experiences and that their evolution is limited not only to the formal diagnosis of psychosis, but also to other mental disorders (e.g., depression) [11]. Schizotypy dimensions are also considered a vulnerability indicator on examining patients with schizophrenia [12], individuals at high genetic risk [13] and at clinical high risk for psychosis [14]. In that regard, schizotypal traits and experiences might represent the behavioural expression of latent vulnerability for psychotic disorders [15]. Healthy individuals who report schizotypal experiences and traits also present emotional, behavioural, neurocognitive, and/or social deficits [1,16–19] that are qualitatively similar, but less severe, than those found in patients with schizophrenia and schizotypal personality disorder. Moreover, the subclinical expression of the psychosis phenotype has been associated with the same risk factors related to psychosis (e.g., cannabis, urbanicity, trauma) conferring aetiological validity on this construct and suggesting a possible continuity between clinical and subclinical psychosis phenotypes [20,21].

The aim of the psychometric high-risk paradigm is the early detection of individuals at high risk for schizophrenia-spectrum disorders using their score profile on measurement instruments. At present, it is considered to be a feasible and useful strategy which allows a series of advantages with respect to other assessment methods, as it is a noninvasive

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method of rapid application and easier administration, scoring and interpretation [7,17]. Moreover, it allows the study of experiences that are similar to those found in patients with psychosis while avoiding the confounding effects frequently found in these individuals (e.g., medication or stigmatization) [16]. The literature in this field holds a wide variety of measuring instruments for the assessment of schizotypy [22]. Among the most widely used are the Chapman's Scales or the Wisconsin Schizotypy scales (WSS). Based largely upon Meehl's [23] theory of schizotypy, in the 70s and 80s, the Chapmans and their colleagues developed different self-report instruments to assess a broad range of experiential and behavioural features of schizotypy [24], as a latent personality organization that harbors the liability for schizophrenia [25,26]. Included in the Chapman's scales, we find the Perceptual Aberration Scale (PAS) [27], Magical Ideation Scale (MIS) [28], Revised Social Anhedonia Scale (RSAS) [29] and Revised Physical Anhedonia Scale (RPhA) [30]. The WSS have shown predictive validity on independent follow-up studies [7,31,32]; its relationship with at-risk mental states and psychological constructs [33,34], its ecological validity [35], its factorial equivalence across cultures [36], sex and age [37] as well as its adequate psychometric properties have also been reported [17,22,24].

Recently, Kwapil and collaborators have conducted a brief version of the WSS (WSS-B) [38,39]. The administration of the WSS takes more time (166 items), so that the construction of an abbreviated version of the four WSS without loss of metric quality can be of great interest from a clinical and research point of view. The selection of the final items that make up the WSS-B was carried out rigorously, and the psychometric properties have been analyzed from the framework of Classical Test Theory (CTT) and Item Response Theory (IRT). Differential item functioning (DIF) was also examined for sex and ethnicity [40]. After item purification of each of the four scales, it was composed of 15 items. Those items with high item difficulty, high discrimination, and low differential item functioning were retained. The psychometric properties of the WSS-B, and particularly of the MIS and PAS brief versions (MIS-B; PAS-B), have been studied previously. Also, using a two-parameter IRT model, it was shown that the four WSS scales effectively assess schizotypy at the high end of the latent trait [38,39].

The previous findings provide preliminary validity of the WSS-B scores. However, it would be interesting to conduct further studies that measure the quality of theses scales on new samples of interest; for example, the analysis of the internal structure of the MIS-B or PAS-B at the item level. Moreover, the detection of these types of individuals at risk for psychosis, whether in clinical or educational settings, requires having adequate measurement instruments that allow us to make solid and well-founded decisions based on the data. Within this research context, the main goal of the present study was to provide new sources of validity evidence of the MIS-B and PAS-B in two samples of non-clinical young adults. In this sense, we can examine the internal structure of the PAS and the MIS brief versions through exploratory and confirmatory factor analysis. We then study the reliability of the scores. We also examine the psychometric properties of the MIS-B and the PAS-B scores using modern measurement models such as IRT and DIF by sex. This allows us to understand the phenotypic expression of the positive dimension of schizotypy in non-clinical populations.

2. Method

2.1. Participants

Participants came from two independent incidental samples of the non-clinical general population. The first subsample was composed of 710 college students from different degree courses at the University of Oviedo (Education, Criminology, Psychology, Medicine, Speech Therapy, IT, Economics and Physiotherapy). The sample was made up of 172 men (24.1%) and 539 women (75.9%). The mean age of the participants was 19.8 years (SD = 1.9), with a range of 17–27. The mean years of education were 16.3 (SD = 1.9). Data from this sample have been used in a previous study [37]. The second subsample was composed of a total of 639 college students from different degree courses at the University of Oviedo (Education, Psychology, Speech Therapy, Economics and Physiotherapy) and the University of La Rioja (Education). This sample was made up of 117 men (18.3%) and 522 women (81.7%). The mean age of the participants was 21.4 years (SD = 2.8), with a range of 17–30. The mean years of education were 18.1 (SD = 2.9). With regard to marital status, 58.8% were single, 37.4% lived in common-law relationships, 2.7% were married, 0.3% were divorced, and 0.8% did not report their status. With regard to employment status, 85.6% were not working and 14.4% were working. Thirty-three percent of this sample reported having a first-degree relative with antecedents of some other psychological disorder. Comparison between subsamples showed statistically significant differences according to age ($t = -11.07$; $p < .001$), but not according to sex ($\chi^2 = 6.68$, $p = .10$).

2.2. Instruments

Magical Ideation Scale-Brief (MIS-B) [28]. It is a self-report scale used for the assessment of superstitious and magical beliefs and thoughts as well as for the capacity of mind reading or thought broadcasting. It is composed of 15 items in a dichotomous True/False format. In the present work, we used the version adapted and validated for the Spanish context [41,42]. This adaptation was made in line with the international guidelines for the translation and adaptation of tests [43,44].

Perceptual Aberration Scale – Brief (PAS-B) [27]. The PAS-B has been used for the assessment of perceptual distortions associated with body image. It is composed of 15 items in a dichotomous True/False format. In the present work, we used the Spanish version [41,42] according to the international guidelines for test translation and adaptation [43,44].

Infrequency Scale [45]. It consists of 13 items in a dichotomous True/False format (e.g. "*Driving from New York to San Francisco is generally faster than flying between these cities*"). The objective is to detect those participants who respond randomly, pseudorandomly or dishonestly to the measuring instruments. This way, those subjects with three or more randomly answered items were eliminated from the final sample. In the present study, we used the version adapted and validated for the Spanish young adult population [41,42].

2.3. Procedure

Administration of the measurement instruments was carried out in groups of 10–50 students during normal lecture hours and in a room with the appropriate conditions. The study was presented to the participants as a research project on diverse personality traits. It was stressed that their participation was voluntary and they were given assurances of the confidentiality of their responses. They received no type of incentive for taking part. Administration of the measurement instruments was always under the supervision of a researcher. This study is part of a broader research initiative on early detection and intervention in the context of psychological disorders in early adulthood and the analysis of psychopathological and personality variables.

2.4. Data analysis

First, we calculated the descriptive statistics for the MIS-B and the PAS-B for each subsample. Second, in the first subsample we analyzed the internal structure of the MIS-B and the PAS-B scores by means of exploratory factor analysis based on the tetrachoric correlation matrix. The procedure employed for determining the number of factors was optimal implementation of Parallel Analysis [46]. This procedure is an implementation of Parallel Analysis where it is computed based on the same type of correlation matrix (i.e., Pearson or polychoric correlation) and the same type of underlying dimensions (i.e., factors) as defined for the whole analysis. The method for factor extraction was Unweighted Least Squares with Promin rotation. Next, in the second subsample, confirmatory factor analysis at the item level was conducted for the MIS-B, the PAS-B, and for both measurement instruments together. We used the weighted least squares means and variance adjusted (WLSMV) estimator. The goodness-of-fit indices employed were: the Satorra-Bentler scaled (χ^2), the Comparative Fit Index (CFI), the Tucker-Lewis Index (TLI), the Root Mean Square Error of Approximation (RMSEA) and Weighted Root Mean Square Residual (WRMR). To achieve a good fit of the data to the model, the values of the CFI and the TLI should be over 0.95 and the RMSEA and WRMR values should be under 0.08 for a reasonable fit and under 0.05 for a good fit [47,48].

Third, the psychometric properties of the items were estimated, under an IRT framework. IRT is a complementary psychometric model and offers many advantages over CTT [49,50]. The two parameter logistic model (2PL) [51] was used. The θ (theta) value represents participants' scores on the latent construct (schizotypy), parameter a (or slope) is related to the item's discriminative power and parameter b (or location) to item threshold or difficulty level. A steeper slope indicates a closer relationship to the construct and therefore a more discriminating item. The larger the location parameter, the more of the measured construct a respondent must have to endorse that item [52]. The θ values are expressed in an ordinal scale, where values usually range from −3 to +3. Moreover, through IRT, an Item Characteristic Curve (ICC) is constructed for each item. This curve, or trace line, reflects the probability of the person's response to each item and his/her level on the latent construct (e.g., schizotypy) measured by the scale. Furthermore, IRT allows us to estimate the contribution each item makes to the assessment for each level of the latent construct: the information function. The inverse of the square root of the information function is equivalent to the standard error of measurement with respect to θ.

Fourth, we estimated the reliability of the scores via Cronbach's Alpha. Finally, we examined the Differential Item Functioning (DIF) by sex. DIF results when examinees from different groups show differing probabilities of success on (or endorsing) the item after matching for the underlying ability the item is intended to measure. The Mantel-Haenszel procedure is among the most widely used for evaluating DIF, given its simplicity of calculation and interpretation. In the present study, we employed the Generalized Mantel-Haenszel test (GMH) [53], specifically the Generalized Ordinal MH statistic (1) -QGMH(1)-. The statistical significance level was set at 0.01. For the data analysis, we used SPSS 15.0 [54], FACTOR 9.2 [55], Mplus 5.2 [56] and GHMDIF [57].

3. Results

3.1. Descriptive statistics of the scales and items

In the first subsample, the MIS-B mean score was 2.15 (SD = 2.29; range 0–11) whereas that of the PAS-B was 1.37 (SD = 2.07; range 0–11). For the first subsample, the values for percentiles 25, 50, 75 and 90 were 0, 1, 3 and 5 for the MIS-B and 0, 0, 2 and 4 for the PAS-B. In the second subsample, the MIS-B mean score was 1.99 (SD = 2.13; range 0–12) whereas that of the PAS-B was 0.83 (SD = 1.57; range 0–13). For the second subsample the values for percentiles 25, 50, 75 and 90 were 0, 1, 3 and 5 for the MIS-

Table 1
Descriptive statistics and factorial loadings for the Magical Ideation Scale-brief and Perceptual Aberration Scale-brief (subsample 1).

	M	*SD*	Skewness	Kurtosis	EFA	Communality
MIS-B						
1	0.25	0.43	1.18	−0.61	0.64	0.41
2	0.26	0.44	1.09	−0.81	0.59	0.35
3	0.14	0.34	2.14	2.58	0.44	0.19
4	0.08	0.27	3.06	7.39	0.64	0.41
5	0.15	0.36	1.93	1.72	0.45	0.20
6	0.25	0.44	1.13	−0.73	0.68	0.46
7	0.16	0.37	1.83	1.33	0.60	0.36
8	0.14	0.34	2.12	2.50	0.47	0.22
9	0.13	0.34	2.17	2.73	0.55	0.30
10	0.15	0.35	2.02	2.09	0.44	0.19
11	0.15	0.36	1.94	1.77	0.40	0.16
12	0.04	0.20	4.56	18.85	0.56	0.32
13	0.06	0.23	3.86	12.91	0.57	0.33
14	0.11	0.32	2.48	4.15	0.53	0.28
15	0.09	0.28	2.96	6.79	0.60	0.36
PAS-B						
1	0.07	0.26	3.28	8.80	0.58	0.34
2	0.02	0.13	7.51	54.58	0.46	0.21
3	0.23	0.42	1.32	−0.27	0.32	0.10
4	0.14	0.35	2.07	2.29	0.75	0.57
5	0.11	0.32	2.48	4.15	0.54	0.29
6	0.05	0.22	4.10	14.89	0.46	0.21
7	0.07	0.26	3.32	9.07	0.56	0.31
8	0.08	0.27	3.13	7.83	0.65	0.47
9	0.12	0.32	2.39	3.72	0.27	0.07
10	0.03	0.18	5.17	24.80	0.55	0.30
11	0.07	0.26	3.24	8.55	0.50	0.25
12	0.13	0.34	2.23	2.98	0.41	0.17
13	0.13	0.33	2.27	3.15	0.57	0.32
14	0.07	0.25	3.50	10.26	0.67	0.45
15	0.06	0.24	3.59	10.93	0.69	0.47

B and 0, 0, 1 and 3 for the PAS-B. The descriptive statistics for the items on both measurement instruments are presented in Tables 1 and 2. Pearson's correlation between the MIS-B and the PAS-B in the first subsample was 0.52 ($p < 0.01$) and in the second subsample it was 0.51 ($p < 0.01$).

3.2. Exploratory factor analysis (EFA)

An EFA was conducted at the item level for the MIS-B and the PAS-B. For MIS-B, the Kaiser-Meyer-Olkin (KMO) was 0.77, and the Bartlett's statistic was 1062.0 ($p < 0.001$). The procedure for determining the number of dimensions suggested the extraction of one factor. The first factor explained 34.75% of the variance (eigenvalue 5.21). The estimated factor loadings and the communality are shown in Table 1. Also, we conducted an EFA for the PAS-B items. The KMO test was 0.77, and the Bartlett's statistic was 2011.6 ($p < 0.001$). The procedure for determining the number of dimensions suggested the extraction of one factor. The first factor explained 34.14% of the variance (eigenvalue 5.12). The estimated factor loadings and the communality are shown in Table 1.

3.3. Confirmatory factor analysis (CFA)

A CFA was conducted in the second subsample. First, a one-dimensional hypothetic model was tested for the MIS-B and the PAS-B separately. Second, the one-dimensional model for both scales and the two-dimensional model for the 30 items that comprised the MIS-B and the PAS-B were tested. Goodness-of-fit indices for the one-dimensional model of the MIS-B were: $\chi^2 = 85.18$, $df = 58$; $p < 0.001$; CFI = 0.95; TLI = 0.96; RMSEA = 0.03; WRMR = 0.94. The standardized factor loadings are shown in Table 2. The goodness-of-fit indices for the one-dimensional model of the PAS-B were: $\chi^2 = 102.93$; $df = 27$; $p < 0.001$; CFI = 0.83; TLI = 0.88; RMSEA = 0.06; WRMR = 1.45. Goodness-of-fit indices for this hypothesized dimensional model were not adequate, given that the overlap in the content of the items allowed for the correlation between error-terms for items 1 and 9, as well as items 5 and 7. Goodness-of-fit indices for the re-specified dimensional model were: $\chi^2 = 56.61$; $df = 26$; $p < 0.001$; CFI = 0.93;

Table 2
Descriptive statistic, standardized factor loadings and IRT estimated parameters (2PL model) for the Magical Ideation Scale-brief and Perceptual Aberration Scale-brief (subsample 2).

	M	*SD*	Skewness	Kurtosis	CFA	IRT	
MIS-B					λ_x	a	b
1	0.09	0.28	2.92	6.57	0.57	0.81	2.19
2	0.10	0.30	2.73	5.47	0.56	0.73	2.23
3	0.13	0.34	2.23	2.97	0.53	0.71	1.97
4	0.08	0.26	3.23	8.47	0.59	0.87	2.24
5	0.25	0.43	1.17	−0.65	0.47	0.48	1.55
6	0.15	0.36	1.95	1.79	0.64	0.89	1.56
7	0.15	0.36	1.91	1.66	0.60	0.80	1.64
8	0.14	0.35	2.03	2.14	0.52	0.67	1.92
9	0.13	0.33	2.25	3.07	0.61	0.84	1.79
10	0.17	0.38	1.73	0.98	0.56	0.74	1.59
11	0.15	0.35	2.02	2.07	0.22	0.24	4.45
12	0.05	0.22	4.21	15.80	0.64	0.96	2.45
13	0.08	0.27	3.07	7.45	0.65	0.96	2.06
14	0.22	0.42	1.35	−0.18	0.41	0.50	1.69
15	0.11	0.31	2.53	4.43	0.49	0.60	2.43
PAS-B							
1	0.05	0.21	4.29	16.49	0.65	0.84	2.67
2	0.01	0.08	12.55	15.98	0.56	1.16	3.43
3	0.04	0.19	4.99	23.01	0.68	1.04	2.55
4	0.10	0.30	2.73	5.47	0.85	1.87	1.50
5	0.05	0.21	4.29	16.49	0.68	1.71	1.94
6	0.03	0.17	5.55	28.90	0.68	1.12	2.58
7	0.05	0.23	3.92	13.43	0.69	1.57	1.91
8	0.18	0.38	1.68	0.84	0.73	1.15	1.24
9	0.04	0.19	4.77	20.77	0.60	0.78	2.95
10	0.02	0.13	7.44	53.54	0.66	1.15	2.88
11	0.05	0.22	4.14	15.15	0.73	1.25	2.13
12	0.10	0.30	2.67	5.15	0.50	0.77	2.14
13	0.04	0.20	4.56	18.87	0.69	1.26	2.23
14	0.06	0.23	3.86	12.92	0.77	1.38	1.98
15	0.03	0.17	5.55	28.90	0.80	1.36	2.36

λ_x = standardized coefficients. All standardized loadings were statistically significant ($p < 0.01$). *a* = discrimination parameter; *b* = location parameter.

TLI = 0.95; RMSEA = 0.04; WRMR = 1.01. Standardized factor loadings for this model are shown in Table 2. Goodness-of-fit indices resulting from the CFA for the one-dimensional model (general dimension of positive schizotypy) taking together MIS-B and PAS-B scores were: χ^2 = 153.67; *df* = 70; $p < 0.001$; CFI = 0.87; TLI = 0.90; RMSEA = 0.04; WRMR = 1.24. Whereas, goodness-of-fit indices for the two-dimensional model (two schizotypy factors: magical ideation and perceptual aberration) were: χ^2 = 139.69; *df* = 69; $p < 0.001$; CFI = 0.89; TLI = 0.91; RMSEA = 0.04; WRMR = 1.19. For this hypothetical dimensional model, the correlation between latent factors was 0.79 ($p < 0.01$)

3.4. IRT: parameter calibration

Table 2 shows the two estimated parameters corresponding to the 2PL model. The interpretation of parameter *a* values is the following: very low 0.01–0.34, low 0.35–0.64, moderate 0.65–1.34, high 1.35–1.69, and very high >1.70. The *b* parameter values range from −3 to +3. Values over 2.0 indicate high difficulty. For example, within the 2PL model, it can be observed that the items of the MIS-B with the greatest level of discrimination parameter were items 12 and 13, whereas the item with the greatest location parameter was item 13. For the PAS-B, the highest level of discrimination parameter was item 4. The item with the greatest location parameter was item 2. For the MIS-B and the PAS-B, items showed high b estimated parameters, displaying high difficulty (>+2).

3.5. Estimation of reliability of the PAS-B and the MIS-B scores

From the CTT perspective, Cronbach's alpha coefficient for the MIS-B in the first subsample was 0.87 and for the PAS-B it was 0.89. In the second subsample, Cronbach's alpha coefficient was 0.86 and 0.78, respectively. According to IRT, the study of measurement precision indicated that both functions provide optimal estimations in those young adults with high latent-trait values (schizotypy) (see Figs. 1 and 2). The information function of the MIS-B and the PAS-B items provides maximum information at +2 level of psychosis-proneness or positive schizotypy.

3.6. Analysis of differential item functioning (DIF) by sex

DIF for sex showed that 3 items of the MIS-B (2, 6 and 8) in the first subsample, and 2 items (8 and 14) in the second subsample displayed differential item functioning by sex. On the other hand, DIF by sex was not found for the PAS-B.

4. Discussion and conclusions

The main goal of this work was to study the psychometric properties of the positive psychosis phenotype through the Magical Ideation Scale brief version (MIS-B) and the Perceptual Aberration Scale brief version (PAS-B) in two samples of college students. For this purpose, we examined the internal structure of the MIS-B and the PAS-B through exploratory and confirmatory factor analyses, and analyzed the reliability of the scores. We also examined the psychometric characteristics of the MIS-B and the PAS-B using modern measurement models such as Item Response Theory (IRT) and Differential Item Functioning (DIF) by sex. The results indicate that the MIS-B and the PAS-B are brief measurement instruments with adequate psychometric properties for the assessment of the positive dimension of the psychosis phenotype.

Analysis of the internal structure, conducted through exploratory factor analysis in the MIS-B and the PAS-B, yielded an essentially one-dimensional structure in both scales. For the MIS-B, goodness-of-fit indices resulting from the hypothesized one-dimensional model were adequate. Goodness-of-fit indices for the PAS-B failed to reach the recommended cut points when the one-dimensional model was tested; nevertheless, when the correlation between error terms was allowed, the goodness-of-fit indices for this

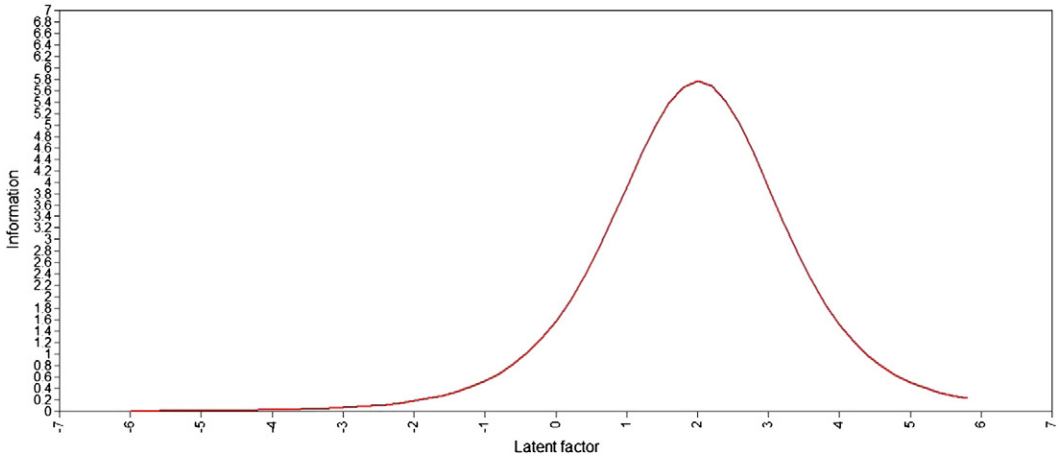

Fig. 1. Information function for Magical Ideation Scale-brief (subsample 2).

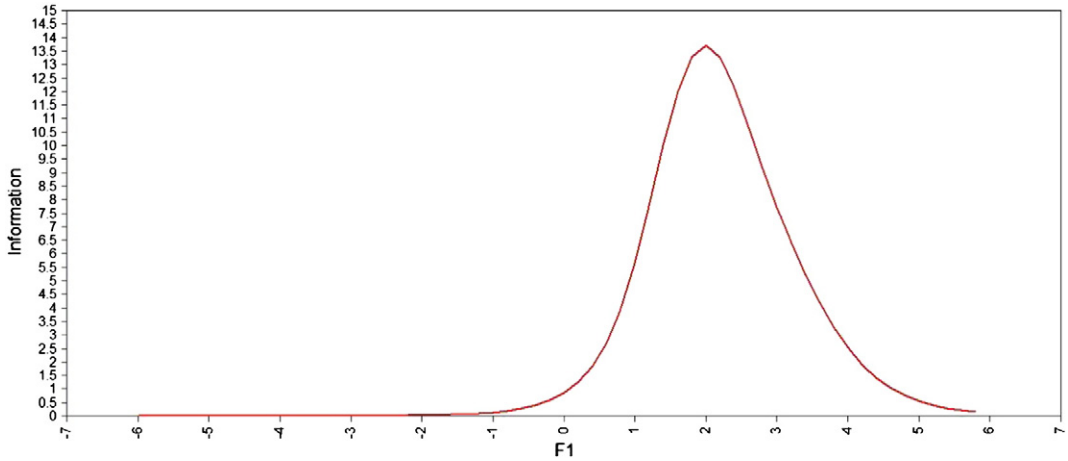

Fig. 2. Information function for Perceptual Aberration Scale–brief (subsample 2).

hypothesized model were satisfactory. These results cannot be compared to other investigations given that no previous studies examining the dimensional structure at the item level of these brief versions have been found. In prior research, it is common to find the assumption that these measurement instruments are one-dimensional; however, this hypothesis needs empirical support. For example, Fonseca-Pedrero et al. [41] found that the MIS and PAS scales in their original versions, displayed an essentially one-dimensional structure. Furthermore, previous work utilizes a total score based upon the sum of items from the MIS and the PAS, which is named the positive dimension of schizotypy [17]. In this sense, it is interesting to analyze whether it is possible to make a composite score with both brief scales. Results showed that the one-dimensional and the two-dimensional models displayed similar goodness-of-fit indices, being a bit better in the two-dimensional model. In both cases, goodness-of-fit indices were in the recommended cut points according to prior literature [47,48]. In addition, it is important to highlight that correlation between the two factors in the two-dimensional model was high (0.79), showing a high overlap. Due to the fact that standardized factor loadings in the two hypothetical models were statistically significant, and considering the parsimony criterion, construction of a total score (positive schizotypy) with the MIS-B and the PAS-B scores might be adequate and supported empirically. Moreover, the construction of a composite total score could be supported by the Pearson's correlation value found between the PAS-B and the MIS-B, which ranged from 0.51 to 0.52, and is similar to the 0.60 value found in previous studies [38,39].

According to IRT, the estimation of the items of the parameters allows us to examine those items that were more discriminative and more difficult to be answered in the MIS-B and PAS-B. Results show that *a* parameter values estimated are not high, which is not the case in *b* parameters. These data are similar to previous studies conducted with the WSS [40], the PDI-21 and the MIS [58]. The analysis of the psychometric properties of the items, in regard to the new psychometric models, allows us to improve our understanding of the latent construct. Psychometric advances allow the incorporation of new applications in the development of measuring instruments for the detection of participants at risk for psychosis according to their level on the latent trait (at risk mental state, psychosis proneness or psychosis phenotype). For example, for a group of people at "low risk" for psychosis, a set of items of moderate difficulty could be presented to evaluate the lower or middle latent trait, while for another group of individuals, such as those at ultra high risk, items of greater difficulty that measured the elevated latent trait more accurately would be more appropriate. In addition, other applications that are derived from IRT, such as computerized adaptive testing, are extremely interesting. Since the study of the psychosis phenotype is a very relevant issue on an international level, and considering that there are some issues of controversy and debate (e.g. attenuated psychosis syndrome), it would be interesting to incorporate these advances in applied research with the aim of improving strategies in early detection, identification, intervention and monitoring.

The Cronbach's alpha coefficient for the total score of the MIS-B was between 0.86 and 0.87, whereas that for the PAS-B was between 0.78 and 0.89. Values found in this study are appropriate, indicating that the instruments are properly measuring the construct. Previous studies have found similar reliability values. For example, Cross et al. [38] with two university samples (n = 6137, n = 2171), found that the reliability values for the MIS-B varied between 0.75 and 0.86, and between 0.84 and 0.95 for the PAS-B. In relation to the reliability estimation, according to IRT, scales provide more information at the high end of the latent construct. This result is interesting as individuals with high scores on the latent trait obtain more precise estimations and with more information compared to those who obtain low scores on the trait. Similar results have been found when the information functions are analyzed with the WSS in

young adults [40] or with the MIS in non-clinical adolescents [58]. These data suggest that the short versions of the MIS and the PAS measure with precision the positive dimension of schizotypy, without losing quality in the estimation of reliability as compared with the original version of the WSS.

Analysis of DIF revealed that five (three items in the first subsample and two items in the second subsample) of the MIS-B items functioned differentially according to participants' sex; nevertheless, no item of the PAS-B showed DIF by sex. Previous research has found that between 23% and 60% of the WSS items showed DIF by sex and ethnicity [40]. Similar results have been found when measuring instruments are administered in order to assess schizotypal traits in non-clinical adolescents [59]. Although these data are preliminary, and future studies must replicate these findings, it is worth mentioning that the presence of DIF does not guarantee equity in the measurement process (no real differences in the traits intended to be measured), so that some consideration of ethical and legal aspects is relevant [60] (e.g., the appropriateness of selecting at-risk individuals for psychosis based on their scores). Likewise, it is advisable for DIF analyses to be incorporated as routine practice in statistical analyses on instruments for assessing the psychosis phenotype (clinical and subclinical).

The results of this research study should be interpreted in the light of the following limitations. First, the sample characteristics (college students and predominantly women) preclude the generalization of the results to other populations of interest. Second, given the problems inherent in any type of study based on self-reports, it would have been useful to employ reports from external informants (e.g., interview). Third, the administration of these types of self-reports is usually associated with stigma [61]. Fourth, only the positive dimension of schizotypy has been assessed in this study. It is interesting to consider that the schizotypy construct is also composed of the Negative and the Disorganization dimensions. In addition, these dimensions must be located within a bio-psychosocial model that takes into account other factors (e.g., genetic, environmental) when explaining the transition toward a clinical disorder and the need of treatment. Finally, it should be borne in mind that this study was of a cross-sectional nature, so that we cannot make cause-effect inferences.

The results found in this work are preliminary and provide new evidence of the internal structure of the MIS-B and the PAS-B scores. Future studies should examine the psychometric properties of the MIS-B and the PAS-B in other samples (e.g., ultra high risk) [62]. These psychometric properties should also be considered in the context of the analysis of measurement invariance across cultures. Likewise, it would be interesting to determine the predictive validity (sensitivity and specificity) of the MIS-B and the PAS-B scores in independent longitudinal studies and to take into account the preoccupation, conviction and stress associated to these experiences and traits [63] in the detection of individuals at risk for psychotic disorders.

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