Validation of the aberrant salience inventory in a general and clinical Spanish population

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ABSTRACT

Background: The concept of aberrant salience is related to the onset of psychosis. Its study is important for early identification and possible intervention in processes activating later positive symptoms.
Objectives: This study validated the Spanish Aberrant Salience Inventory (ASI) for adult and clinical populations.
Methods: The sample consisted of 6178 participants, of whom 4523 were adolescents, 1292 were general population adults and 363 were patients with a psychopathology.
Results: The evidence provided validates the instrument's structure. Invariance of measurement suggests that both men and women, patients and nonclinical population (adults and adolescents) interpreted the items on the ASI similarly. The distribution of scores by age also suggests stabilization of the trend at about 19 years of age, showing a developmental change in motivational response. The hypothesis that patients, and in particular, those diagnosed with schizophrenia and other psychotic disorders and bipolar disorders would have the highest average scores in aberrant salience was met.
Conclusions: This is a valuable instrument for evaluating a complex process related to abnormal motivation in the development of schizophrenia.

1. Introduction

Much of the effort devoted to the study of psychosis in general, and schizophrenia in particular, has been directed at its prodromal stages and the onset of the psychotic process [1,2]. Early detection makes it possible to use available resources to slow down or curtail this process, presumably favoring better adjustment or recovery of the person affected [3], and reducing its impact on the person's surroundings.

The concept of aberrant or abnormal salience has been proposed as a characteristic indicator of the onset of the psychotic process, particularly schizophrenia [4]. Kapur [5] described it as a change, altered motivation and attention to elements in one's experience, such that neutral and irrelevant stimuli become abnormally salient (decreasing attribution of salience to rewards) [6]. From there, a state of perplexity and unusual

significance appears before crystallization in delusion [7]. Aberrant salience is, then, alteration of the natural motivation toward novelty/reward attributed to the dopaminergic dysregulation traditionally linked by some authors to the onset of psychosis [8,9].

Aberrant salience was included in the classic descriptions of delusional mood or atmosphere, which emphasized the feeling of imminence or perception of strangeness of one's environment. However, in the current diagnostic classifications, this characteristic process is not alluded to, and could be misinterpreted as anxiety or depression [10].

Going beyond the characteristic positive symptoms, alterations of self-experience have been proposed in the ICD-11 as one of the criteria for diagnosis of schizophrenia [11]. The current phenomenological tradition revitalizes the more Bleulerian conception of schizophrenia [12] with these alterations of the self-experience or minimal self. These

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indicators, often diffuse, are related to exaggerated self-consciousness (hyperreflexivity), diminished sense of self, or loss of vital contact with reality, to mention three fundamental contents. They are described exhaustively by such instruments as *Examination of Anomalous Self-Experience* (EASE) [13] for self-awareness, and *Examination of Anomalous World Experience* (EAWE) [14] for awareness of the world. Some of these experiences are basic symptoms in the study of early prodromes [15,16], although they concentrate on experiences related to belonging and agency of the self [17,18]. Aberrant salience may be implicit in some of these experiences [19], particularly in its role in context: perplexity in interaction with others, sharpness in the perception of one's surroundings, etc. Aberrant salience has been said to be connected more with anomalous experience of the world (space, time, others, atmosphere, existential orientation) than with minimal or essential self-experience, although the two constructs overlap [18]. A definition of what is understood by aberrant or abnormal salience and its role is therefore necessary, precisely because of the possible relationship with these minimal self-experiences and other processes close to delusion.

The concept of delusional mood or atmosphere triumphs with Jaspers, who emphasized perception, not as a concrete emotion or affect, but an overall strange (basic) mood state where familiarity with the world is lost, occasionally after self-referential experiences and development of abnormal meaning [20]. Conrad [21] organized this very particular gestalt experience in phases, placing distrust and delusional mood in a specific phase he called *trema,* where distressing experiences occur, in addition to depersonalization or derealization, and irrelevant details or events acquire a new character, but still make no clear sense. He places abnormal meanings (Jaspers), relationships with no reason (Gruhle), and the birth of delusional perception (Schneider), in the *apophenia* phase. That is, aberrant salience begins in the trema phase and is exteriorized or becomes concrete in apophenia [22].

Although classical contributions attempt to show a single phenomenon which captures the essence of this moment prior to psychotic development, it is hard to disconnect this process of dopaminergic sensitization, presumably based on abnormal assignment of salience to stimuli, from other processes such as anticipation of threat [23], search for meanings [24,25], or emotional states activated.

In view of the factors involved, the evaluation of this delusional mood, or in more recent terms, aberrant salience, is extraordinarily complicated, as it does not recur directly to concrete meanings, to recognizable perceptive alterations, nor to emotional states that can be easily communicated. Evaluations of prodromes often include some reference comparable to aberrant salience [13,15] frequently as unusual thought content [26,27], as in the *Comprehensive Assessment of At-Risk Mental States* (CAARMS) interview, where it is related with ideas of reference in the same item, although implying a different level of severity.

The Aberrant Salience Inventory (ASI) [28] is the only self-report instrument specifically developed to evaluate this process. It has been validated in French, Spanish and Italian [9,29,30].

Even though, as mentioned above, aberrant salience is closely related to alterations of the minimal self [18], an analysis of the content of the ASI items enables the sense of possible motivational changes in the setting and in the person (including feelings and changes in emotions, although unspecified) to be perceived. The difference between alterations of the self (affectation of first-person experience, of its limits, its internal processes, etc.) [31] and aberrant salience (altered motivation and attention) may have to do with their being different, but complementary, conditions, perhaps, trait and state, respectively [22]. In view of these conditions, aberrant salience should be more clearly present in prodromes than in consolidated psychotic disorders [9,32,33], and therefore also present, although to a lesser extent, in trait dispositions such as schizotypal disorder [10]; it should be related to positive indicators closer to the decompensation process, such as ideas of reference, than other indicators, such as vulnerability or trait, or than active positive indicators [22,34,35]. Along this line, as stimulus salience is a

developmental activation process that is not exclusively pathological [22], it should be found more during adolescence than in other stages of life, although less so than in individuals with a psychopathological diagnosis [9].

Given the importance of aberrant salience, and the number of unknowns involved, particularly its self-evaluation, the following objectives were proposed in this study:

1) Validate the ASI inventory in an adult general population and with individuals diagnosed with psychosis, following prior validation with an adolescent general population [30].

2) Find the relationship of aberrant salience with measures of positive symptoms to test the hypothesis (2.1) that aberrant salience is related more to ideas of reference and indicators of vulnerability to psychosis than to active psychotic dimension symptoms.

3) Analyze the characteristics of ASI scores in three populations (adolescent and adult general populations and adult patients) to test the following hypotheses: 3.1) Scores will be highest in the group of patients, followed by adolescents (as a motivational process related to the development of self; [36]), and finally the adult group.

3.2) In the score distribution, adolescents will score closest to the measure's overall mean, and general population adults will score lowest

3.3) There will be significant differences in Aberrant salience by diagnosis, where patients with schizophrenia and other psychotic disorders and bipolar disorder will score higher than others.

2. Method

2.1. Participants

The study sample was comprised of 6178 participants, of whom 4523 were adolescents, 1292 were general population adults and 363 were patients with a psychopathology. Of the adult general population participants, 5.9% ($n = 76$) had a history of some mental health-related problem (not counted in the group of adolescents), while 58% of the group of patients ($n = 209$) had a psychopathological history. (See Table 1). The adult participants from the general population were recruited by snowball sampling by a group of undergraduate psychology students, each of whom had to provide several contacts and each contact in turn served as the connection to further contacts (so participants would not be limited to their family circles or acquaintances). The patients came from several public and private clinical psychology centers in Western Andalusia (Spain). The diagnoses were made by healthcare professionals (clinical psychologists, general psychologists and

Table 1
Sociodemographic characteristics of the sample and clinical diagnoses.

	Adolescents ($n = 4523$)	General population adults ($n = 1292$)	Patients ($n = 363$)
Sex (% women)	53.6%	69.1%	53.7%
Age (M, SD)	14.31 (1.66)	27.64 (11.90)	35.45 (13.39)
Age range (years)	11–18	18–80	17–79
Diagnoses (n)	–	–	Depressive D. = 55
			Adjustment D. = 11
			Eating D. = 8
			Anxiety D. = 72
			Schizophrenia and other D. Psychotic = 149
			Bipolar D. = 16
			Somatoform D. = 11
			Personality D.[1] = 27
			Other[2] = 14

[1] Personality D: Paranoid Personality D. = 4; Schizotypal Personality D. = 5; Schizoid Personality D. =1; Histrionic personality D. = 2; T. Borderline Personality D. = 8; T. Dependent Personality D. = 1; Unspecified Personality D. = 6.
[2] Others: Dissociative D. = 1; Sexual D. = 1; HADD = 5; Others applicable to Axis I = 3, T. Addictive = 1; Neurodevelopmental D. = 2; Impulse Control D. = 1.

psychiatrists) with wide clinical experience following the DSM-IV-TR classification [37].

2.2. Measures

A questionnaire designed by the authors was administered to collect the participants' sociodemographic variables, medication and psychopathological history. Then the evaluation instruments described below were administered.

Aberrant Salience Inventory [28] (**ASI**, Spanish version by Fernández-León et al. [30]). This test evaluates assignment of meaning or importance to usually irrelevant stimuli in 29 items with a dichotomous (true or false) answer format (e.g., 5. "Do you sometimes notice small details that you have not noticed before that seem important?"). It has five dimensions: Heightened Cognition, Impending Understanding, Heightened Emotionality, Increased Significance, and Senses Sharpening. A total score is possible by adding up the affirmative answers. The authors reported a Cronbach's Alpha = 0.89 for the complete scale and evidence of concurrent validity with other psychosis proneness measures. The ASI was validated with the same sample of Spanish adolescents used in this study [30], where the factor structure proposed by the authors and a second-order general factor, which enabled interpretation of the total score, were corroborated. Psychometric properties (Ordinal α = 0.95 for the total scale) and evidence of concurrent validity with other measures of positive and negative symptoms were adequate.

Referential Thinking Scale [38] (**REF**, Spanish validation by Rodríguez-Testal et al. [35]). This scale evaluates the interpretation of casual situations where a person may feel watched, laughed at or noticed. It consists of 34 items with a true or false answer format. Five first-order factors and one second-order factor were found in the Spanish validation. The total scale score was used in this study. The psychometric properties were favorable in all the samples with an ordinal α for the total score that varied from 0.94 (adolescents) to 0.97 (patients and general population adults).

Community Assessment of Psychic Experiences-42 [39] (**CAPE-42**, Spanish validation by Fonseca-Pedrero et al. [40]). This instrument evaluates attenuated positive and negative psychotic and depressive symptoms. It consists of 42 items with a four-choice Likert-type answer format (from "almost never" to "almost always"). Internal consistency of the Spanish validation was from 0.78 to 0.89 in the sample of university students and from 0.84 to 0.93 in patients with psychosis. In this study, the total scale score was used, but focused mainly on CAPE positive symptoms. This instrument was administered to 250 participants ($n = 226$ general population adults and $n = 24$ patients). Internal consistency was 0.88 for the global CAPE and 0.76 for the Positive CAPE.

Brief Psychiatric Rating Scale [41](**BPRS,** Spanish validation by Peralta-Martín and Cuesta Zorita [42]). This other-reported scale has 24 items which evaluate positive (psychotic and disorganized) and negative emotional symptoms. The answers to the items vary from 1 (not present) to 7 points (extremely severe). The Spanish validation has 18 items with reliability of $\alpha = 0.59$ to 0.70, and retest reliability of 0.70. In this study, only the psychotic dimension was used (Items 6. Suspiciousness, 7. Unusual thought content, 8. Grandiosity, 9. Hallucinatory behavior; [43]. This scale was administered to 379 participants ($n = 263$ patients and $n = 116$ general population adults). Internal consistency for this study was 0.84 for the psychotic dimension of the BPRS, 0.81 for the group of patients, and 0.73 in the control group.

2.3. Procedure

Approval was received from the author for the Spanish adaptation of the ASI, which was back-translated by two expert translators with clinical knowledge, one native English speaker and one Spanish [30], following standardized adaptation instructions [44]. Recruitment of the sample of adolescents is described in Fernández-León et al. [30]. Of this group of adolescents 79 were discarded previously because of

incomplete answers on the tests. Of the general population adults, 51 were discarded because of incomplete answers on the tests. In the group of patients, there were no missing values, and test completion was reviewed with each participant.

All the participants were informed of the objectives of the study and gave their written consent to participate. Parents or legal guardians of the adolescents signed their consent. The study was approved by the Ethics Committee of the Junta de Andalucía [Andalusian Regional Government] (PI 010/16).

2.4. Data analysis

For the first objective, a Confirmatory Factor Analysis was done with the sample of general population adults and patients, testing the factor structure found in the validation of the ASI [30] against the adolescent sample included in that study. The diagonally weighted least squares (WDLS) method was applied to the asymptotic covariance matrix. The following parameters were used for goodness-of-fit analysis of the factor structure: Satorra Bentler Chi^2, non-normed fit index (NNFI) and the comparative fit index (CFI), which must be >0.90 [45]. The root mean square error of approximation (RMSEA) and its 90% confidence interval (CI) were calculated, which for a good fit must be <0.06, as well as the standardized root mean residual (SRMR) which has to be <0.08 [46].

The ASI factor structure was subjected to a multi-group CFA for testing measurement invariance in a series of hierarchical steps in which increasingly stringent restrictions were placed on the parameters to be estimated. The invariance analyses were tested across patients and general population adults, then across the general population adults and adolescents. Invariance across gender was also tested. Testing began with a CFA in each group separately. Then, the baseline model was estimated (configural invariance: M0) across the populations evaluated. Configural invariance is the least stringent model and implies that the parameters are freely estimated in each group. Next, a metric invariance analysis (M1) was carried out, in which the factor loadings were constrained to equality in each comparison group and fit of model M1 was compared to M0. Finally, scalar invariance was analyzed, where the item-factor intercepts were constrained and this model was compared to M1. Chen's [47] criterion was used to test whether the models compared were equivalent, where the invariance hypothesis is met if ΔCFI <0.01 and ΔRMSEA<0.015.

After that, the reliability of the scores on the ASI dimensions and total score was estimated using the ordinal ω, which is more appropriate for dichotomous variables. Discrimination indices were also analyzed. For Objective 2, Pearson correlations were found between the ASI, REF, CAPE, and BPRS to corroborate the evidence of validity compared to other external variables (for adult participants).

For Objective 3, the adult and adolescent general population samples were divided into age groups from 11 to 19, from 20 to 29, from 30 to 39, from 40 to 49, from 50 to 59, and from 60 to 80. A one-way ANOVA was done of the age groups over the mean ASI score. Then the frequency of ASI item answers in each age group was analyzed. In the group of patients, an ANOVA was done to test whether there were any differences in the ASI with respect to psychopathological diagnosis. A one-factor ANOVA of the three study samples and a post hoc test were performed on the total ASI score. Finally, the sensitivity and specificity of the scale were analyzed using the ROC curve to find an ASI cutoff point. The statistical analyses were performed with Lisrel 8.7, SPSS 24, and Jamovi 1.6.6.0 software.

3. Results

3.1. Evidence of validity based on the internal structure

A confirmatory factor analysis was performed with the samples of patients and general population adults. The factor structure found in the study by Fernández-León et al. [30] with adolescents was tested. The

two-factor solution with one general factor and five dimensions had optimum goodness-of-fit indices: Satorra Bentler $Chi^2_{(372)}$ = 1004.55, CFI = 0.995, RMSEA = 0.031, IC 90% [0.030, 0.034], NNFI = 0.994, SRMR = 0.057. Fig. 1 shows the model with one second-order factor and five first-order factors with its standardized factor loadings which varied from 0.47 to 0.92.

3.2. Invariance of ASI measurement across population (patients, adults and adolescents) and gender

First, CFAs were carried out on the samples separately. In all cases, the goodness-of-fit indicators were appropriate. Then configural invariance was analyzed (M0) to test whether the factor structure (number of factors) and the items loading on each factor were equivalent in the population groups analyzed. Tables 2, 3 and 4 show that the goodness-of-fit indices reached recommended values (CFI >0.95 and
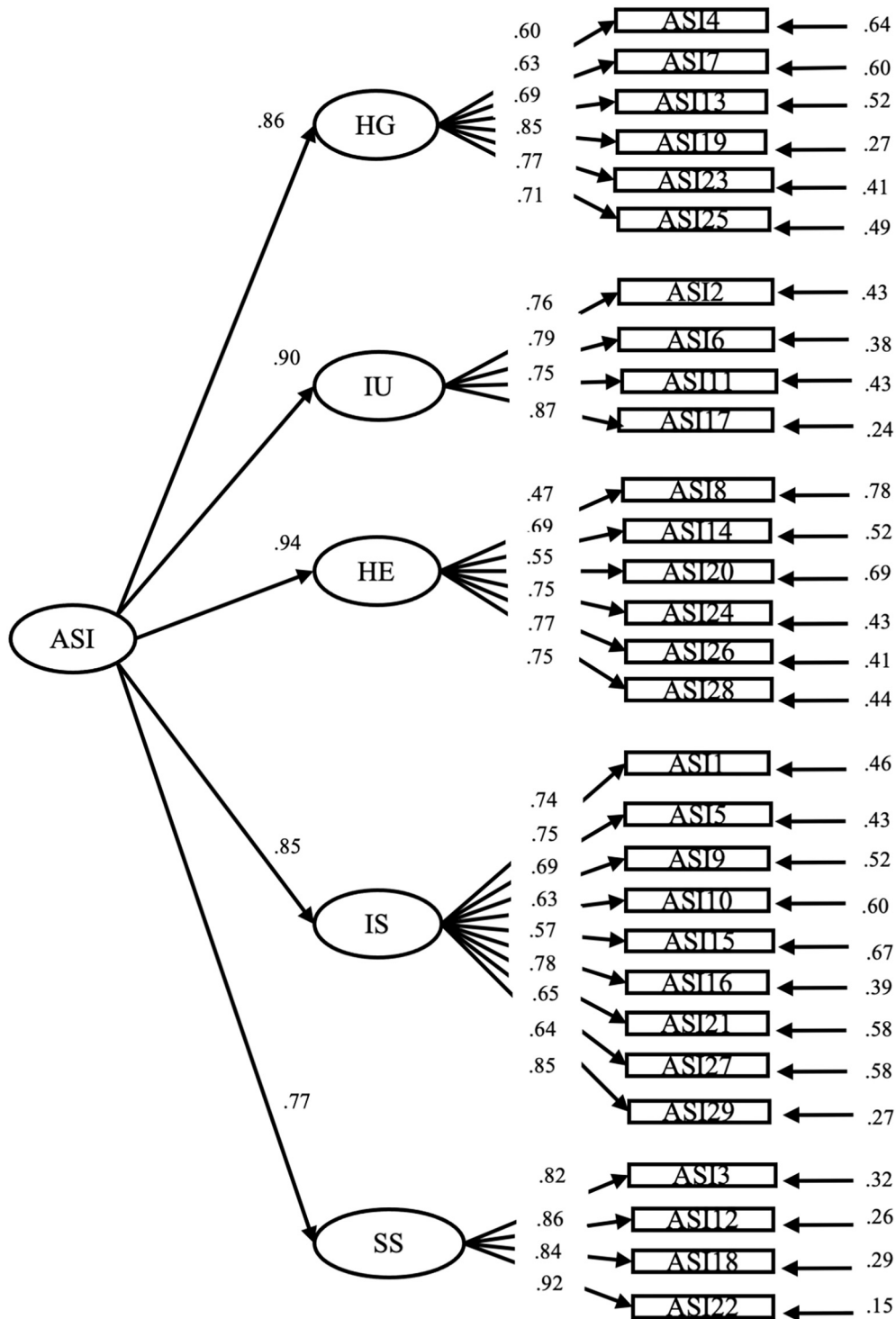

Fig. 1. Factor structure of the Aberrant Salience Inventory. Standardized solution. HG: Heightened cognition; IU = Impending understanding; HE = Heightened emotionality; IS = Increased significance; SS = Senses sharpening.

Table 2

Invariance of measurement in ASI scores across sample (general population vs. clinical population).

Model	$SB\chi^2$	df	CFI	RMSEA [IC 90%]	ΔCFI	ΔRMSEA
General population	783.15*	372	0.995	0.029 [0.027, 0.032]		
Clinical population	524.92*	372	0.993	0.033 [0.027, 0.040]		
Configural invariance	1365.49*	745	0.994	0.032 [0.023, 0.034]		
Metric Invariance	1416.04*	769	0.994	0.032 [0.029, 0.035]	<0.01	<0.015
Scalar invariance	1496.61*	807	0.993	0.032 [0.030, 0.035]	<0.01	<0.015

 * $p < .01$.

Table 3

Invariance of measurement in ASI scores across age.

Model	$SB\chi^2$	df	CFI	RMSEA [IC 90%]	ΔCFI	ΔRMSEA
Adults	783.15*	372	0.995	0.029 [0.027, 0.032]		
Adolescents	1981.67*	372	0.985	0.031 [0.030, 0.033]		
Configural invariance	2374.73*	745	0.987	0.028 [0.026, 0.029]		
Metric invariance	2568.28*	769	0.987	0.028 [0.027, 0.030]	<0.01	<0.015
Scalar invariance	3206.48*	807	0.983	0.032 [0.031, 0.033]	<0.01	<0.015

 * $p < .01$.

Table 4

Invariance of measurement in ASI scores across gender.

Model	$SB\chi^2$	df	CFI	RMSEA [IC 90%]	ΔCFI	ΔRMSEA
General population women	569.93*	372	0.996	0.025 [0.020, 0.028]		
General population men	526.33*	372	0.994	0.032 [0.026, 0.039]		
Configural invariance	1103.92*	745	0.996	0.027 [0.024, 0.031]		
Metric invariance	1138.98*	769	0.996	0.027 [0.024, 0.031]	<0.01	<0.015
Scalar invariance	1163.36*	807	0.996	0.027 [0.023, 0.030]	<0.01	<0.015
Female clinical population	456.85*	372	0.993	0.034 [0.018, 0.045]		
Male clinical population	441.60*	372	0.993	0.034 [0.018, 0.045]		
Configural invariance	3163.52*	745	0.968	0.071 [0.069, 0.073]		
Metric invariance	3246.89*	769	0.968	0.071 [0.068, 0.073]	<0.01	<0.015
Scalar invariance	3302.88*	807	0.967	0.069 [0.067, 0.072]	<0.01	<0.015

 * $p < .01$.

REF$_{(n=1655)}$ = 0.508. Increased significance and Senses sharpening showed more modest results, but with respect to the BPRS$_{(n=379)}$ = 0.440 and 0.452, respectively, should still be mentioned.

3.5. Analyses related to participant populations

The one-way ANOVA by age range over the total ASI score in the two general population samples found statistically significant differences $F(5, 5809) = 161.32, p < .001, \eta^2 = 0.12$. Results of a post hoc Dunnet test showed that the group of adolescents differed from the other groups with a much higher mean on the ASI with large effect sizes which varied from Cohen's $d = 0.73$ to 1.01. Fig. 2 shows the mean ASI scores on the ordinal axis and participant age on the abscissa. As there were fewer participants in the oldest age categories, participants over 35 years of age were grouped together in Fig. 2.

Although the linear trend is slightly upward, it is very stable from ages 11 to 18 (least squares: $y = 0.3691 \times + 13.367; R^2 = 0.8815$), and visual inspection shows the practically stable trend from age 19 on, although with poor fit to this linear trend ($y = 0.022 \times + 9.394; R^2 = 0.018$). A frequency analysis was done of ASI items answered affirmatively in each sample (see supplementary material).

A one-way ANOVA was done of psychopathological diagnoses grouped by category over the total ASI score. As shown in Table 7, statistically significant differences were found. The Tukey's post hoc test demonstrated that patients with depressive disorders differentiated in ASI score from patients with schizophrenia and other psychotic disorders (Cohen's $d = 0.79$) and bipolar disorder (Cohen's $d = -0.83$).

3.6. Comparison of mean score on ASI by population

An ANOVA was performed of the total score on the ASI by population group. Statistically significant differences were found: $F(2, 6175) = 500.14, p < .001$ (Means: Patients = 15.86 ($SD = 7.02$), general population = 9.49 ($SD = 5.99$) and adolescents = 15.07 ($SD = 5.51$), with a

RMSEA <0.06). Then, metric invariance (M1) was analyzed, and the CFI and RMSEA for M1 and M0 were compared. The criteria for invariance were met in all cases (ΔCFI<0.01 and ΔRMSEA<0.015), showing that the group factor loadings were equivalent. Finally, scalar invariance was tested (M2), and there was no significant increase in CFI or RMSEA when M2 and M1 were compared. This invariance suggests that the intercepts of regression lines relating each item to its factor are the same in all the samples analyzed [47].

3.3. Reliability estimation of ASI scores

Internal consistency of the scale's global score and factors was evaluated in the samples with the ordinal omega. In all case, values were over 0.70 (Table 5). The discrimination indices of all the factors were over 0.30. The ASI was administered to 244 participants after 15 days to find the retest reliability, which was $r = 0.89$.

3.4. Evidence of validity with respect to other scales

Pearson correlations were estimated to find evidence of validity with regard to external variables. All the correlations were positive and statistically significant (Table 6). The total ASi, r ASI-REF$_{(n=1655)}$ = 0.567, and r ASI-BPRS$_{(n=379)}$ = 0.587 are worth mentioning. Attention is called to the ASI Heightened cognition and Impending understanding factors compared to the BPRS Psychotic dimension$_{(n=379)}$ = 0.498 and 0.470, respectively, and Heightened emotionality with regard to the

Table 5

Reliability of the ASI factor scores and total score by subsamples.

ASI	F1	F2	F3	F4	F5	Total
ω ordinal						
Adults	77	77	81	86	86	92
Clinical population	85	87	85	92	92	96
Adolescents	91	87	90	88	92	95
Discrimination indices	0.31–0.50	0.48–0.54	0.38–0.53	0.42–0.58	0.43–0.51	0.30–0.53

F1: Heightened cognition; F2 = Impending understanding; F3 = Heightened emotionality; F4 = Increased significance; F5 = Senses sharpening.

Table 6

Pearson correlations of the ASI scale and factors with psychotic dimension measures (adults).

ASI	F1	F2	F3	F4	F5	Total
REF ($n = 1655$)	0.459	0.458	0.508	0.431	0.369	0.567
BPRS ($n = 379$)	0.526	0.456	0.540	0.440	0.452	0.587
BPRS-P ($n = 379$)	0.498	0.470	0.401	0.377	0.426	0.521
CAPE-42 ($n = 250$)	0.298	0.378	0.465	0.380	0.186	0.497
CAPE-42-P ($n = 250$)	0.376	0.440	0.335	0.375	0.258	0.504

Note: All the correlations were statistically significant $p < .01$. F1: Heightened cognition; F2 = Impending understanding; F3 = Heightened emotionality; F4 = Increased significance; F5 = Senses sharpening. REF: Referential Thinking Scale; CAPE-42: Community Assessment of Psychic Experiences-42; CAPE-42-P: Psychotic dimension from Community Assessment of Psychic Experiences-42.
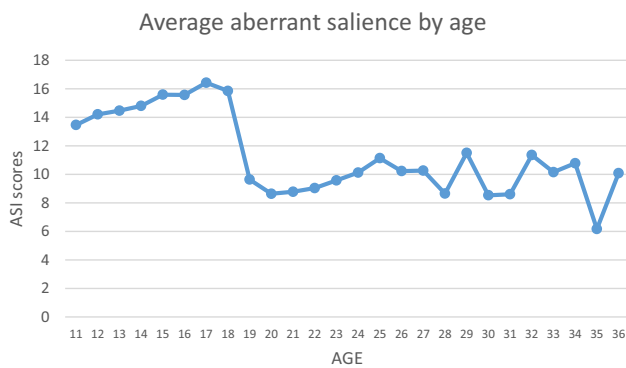

Fig. 2. Distribution of the mean scores on the ASI by age (sample of adolescent and adult general population $n = 5815$).

Table 7

One-way ANOVA between psychopathological diagnosis groups over total ASI score.

Diagnoses	Mean (SD)	df	F (p)	η^2	Tukey
1. Anxiety D. ($n = 76$)	14.96 (6.57)	8	4.20 (<0.001)	0.09	N·S.
2. Bipolar D. ($n = 18$)	18.11 (6.80)				3 < 2
3. Depressive D. ($n = 54$)	12.31 (7.04)				2 > 3, 4 > 3
4. Schizophrenia and other psychotic ($n = 149$)	17.79 (6.84)				3 < 4
5. Adjustment D. ($n = 11$)	14.73 (6.31)				N.S.
6. Eating behavior D. ($n = 8$)	12.50 (6.35)				N.S.
7. Somatoform D. ($n = 11$)	16.46 (7.38)				N.S.
8. Personality Group A D. ($n = 10$)	14.10 (6.84)				N.S.
9. Personality Group B D. ($n = 10$)	15.40 (3.81)				N.S

N.S. = non-significant differences $p > .05$.

large effect size $\eta^2 = 0.14$. A post hoc Dunnet's test found statistically significant differences between patients and general population adults (Cohen's $d = 1.02$), between patients and adolescents (Cohen's $d = 0.14$) and between adolescents and general population adults (Cohen's $d = -0.99$).

3.7. ROC curve

The ROC curve was calculated (Fig. 3) to find the ASI cutoff point, and its sensitivity and specificity, considering patients with Schizophrenia and other psychotic disorders, and bipolar disorders. The area under the ROC curve was statistically significant for the total ASI score (area = 0.80, $p < .001$, CI 95% [0.76, 0.83]) at a cutoff point of 14 with 69% sensitivity and 74% specificity.

4. Discussion

This study proposed the analysis of some characteristics related to measurement of aberrant salience in the general and clinical populations using the ASI inventory [28]. In view of the importance of early psychotic development, particularly with respect to delusional mood, described from the more classic works (Gruhle, Jaspers, Matussek, Conrad and others) to the proposal by Kapur et al. [8] of aberrant salience, and the lack of self-report instruments that can measure it, the main objective of this study was to validate the ASI inventory in an adult Spanish general population and a group of patients, as previously done with an adolescent general population [30].

In general, and as the first objective, some indications are given of
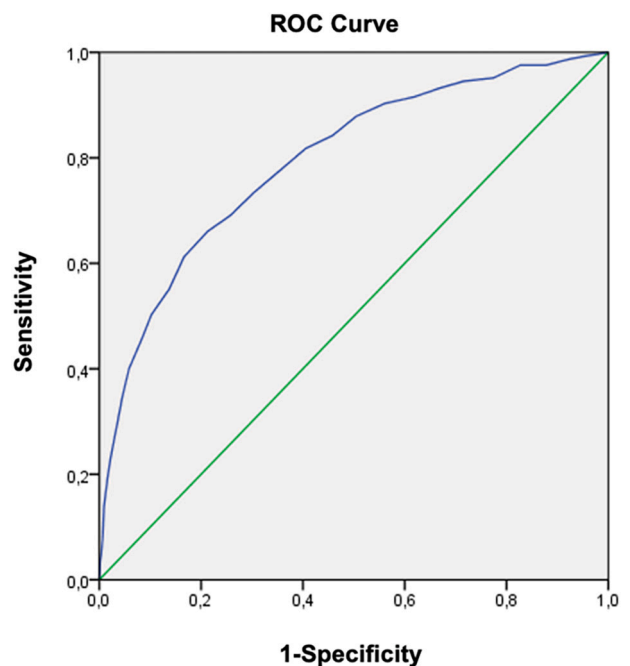

Fig. 3. ROC Curve for sensitivity and specificity analysis of the Aberrant Salience Inventory (ASI).

the validity of the instrument's structure, in agreement with its original validation [28], and as tested in our context with an adolescent population [30]. The five second-order factors found by its authors were verified: *Heightened cognition* (e.g., 19. "Do you ever feel like the mysteries of the universe are revealing themselves to you?"); *Impending understanding* (e.g., 11. "Do you sometimes feel like you are finding the missing piece to a puzzle?"); *Heightened emotionality* (e.g., 26. "Do you ever have a feeling of inexpressible urgency, and you are not sure what to do?"); *Increased significance* (e.g., 1. "Have certain trivial things suddenly acquired importance or special meaning for you?"); *Senses sharpening* (e.g., 3. Do your senses (sight, hearing, etc.) sometimes seem sharpened?"). The indicators of sensitivity and specificity (69% and 74%, respectively) were adequate.

Invariance of measurement across the population and gender groups suggests that both men and women, patients and nonclinical population (adults and adolescents) interpret the items on the aberrant salience inventory similarly, and therefore, it is possible to compare the mean scores on the items and the complete scale in different populations.

Evidence of comparative validity, the second objective, highlights significant positive correlations, particularly with respect to ideas of reference, as predicted, but more so with the positive vulnerability measure (CAPE) and the active psychotic dimension (BPRS; patients with a variety of diagnoses). The relationship between aberrant salience and ideas of reference has been confirmed in the literature, for example, in a population with psychotic experiences [35,48], showing that they are clinically very close processes, described by their emergence at different times, from unspecific imminent experiences and perceived changes in the person's environment and mood (aberrant salience) to externalization, where the actions of others often take on significance (ideas of reference) [10]. However, the relationship between the ASI measurement with positive symptoms (BPRS) and positive vulnerability (CAPE) was not as clearly differentiated as expected, although similar to what has been found in other studies that have approached psychotic experiences or first episodes in young people [49,50].

These results may not have been as expected because some of the measures, such as the BPRS, include both unusual thought content (therefore near aberrant salience) as well as other positive contents, such as delusions or hallucinations. Thus, the BPRS may not be verifying that aberrant salience has less of a relationship with consolidated psychotic symptomatology. Perhaps aberrant salience does not change so drastically from the first signs to emergence of positive symptoms [33], but depends on other processes for the relationship with delusional content already crystalized and its maintenance [51].

The correlation of aberrant salience and the vulnerability measure (CAPE) was quite a bit lower than expected. The correlations between the ASI factors and the positive dimension measures observed are of interest. The most robust relationship with the vulnerability measure (CAPE) was with Impending understanding, while ideas of reference (REF) had a very strong relationship with Heightened emotionality. Active symptoms (BPRS) had the strongest relationship with the Heightened cognition factor (for the psychotic dimension) and Heightened emotionality (total BPRS, that is, including emotional indicators). The strongest relationships with the other measures were with Heightened cognition and Heightened emotionality (more aberrant salience) in particular, while the lowest correlations were with Senses sharpening (moderate correlation with BPRS). One possible explanation for this result is that the vulnerability measure (CAPE) may be too general or static, and the design used is not sensitive enough to identify the subtle changes in the contents shown by the ASI factors. This may suggest signs of content changing depending on the moment in the process's development, when there would be a connection between ideas of reference and emergence of aberrant salience on affects that are still not consolidated in emotional states, but related to senses when there is more concrete positive symptomatology present. So it is possible that changes in aberrant salience could occur in a theoretical order from the measure of vulnerability, to ideas of reference, to active symptoms, clearly rising

at the moment when the search for external meaning begins (ideas of reference) [22,48]. This could show aberrant salience going from trema to apophenia, in the terminology of Conrad [21], to later diminish again when general positive symptoms take on stronger prominence [7,9]. Future studies could confirm the deployment of contents and expressions of aberrant salience measured with the ASI based on a prospective design, which would also enable verification of its location between vulnerability and consolidation of active psychotic symptoms.

For the third objective of this study, the aberrant salience (ASI) measurement was compared with the participant's developmental stage (general population) and characteristics of the adult patients. The hypothesis that patients would have the highest scores in aberrant salience was met, particularly the average among those diagnosed with schizophrenia and other psychotic disorders and bipolar disorders. The group of general population adolescents had a very high average close to the patients. This result could have to do with the changes in cerebral reorganization and hyperreactivity of the dopaminergic system that are taking place precisely during adolescence more than in other developmental stages [52]. The results in Fig. 2 show that the average adolescent ASI scores are consistently higher up to 18 years of age, then drop off sharply at 19, which would fit with that explanation. In this study, unlike most others, inclusion in the group of adolescents started at age 11, which is a novelty in the study of aberrant salience. With university student samples, Cicero et al. [28](Study 2) and Raballo et al. [9] found averages of 12–13 points on the ASI for ages 19 to well beyond the third decade of life, and more pronounced than what was observed in this study for the same ages ($M = 9.61$, $SD = 1.25$). According to our data, the trend stabilizes at around 19 years of age, although with wide variation in the average scores (Fig. 2). This distribution is different from ideas of reference [35] insofar as breadth of variation, although timing of score stabilization is similar. This pattern suggests that there is a change in motivational response as the various levels of functioning adjust during development, diminishing the risk that more biased stimulus salience could lead to. The comparison of the three groups by number of items answered again suggests a normal distribution. Most of the adolescent scores were high, as predicted, differing widely from the distribution observed in adults, whose scores were similar to those for ideas of persecution in the general population [53].

The results of Pelizza et al. [54] with participants with first episodes and at-risk mental states (criteria established by interview) are of interest in this sense, as the scores were around 13–14 points, with no significant differences found between adolescents and adults. The group of participants that did not meet the high-risk criteria had an average of 4.87 points ($SD = 5.46$), clearly very low for this group, which had an average age of 22. Cicero et al. [28] (Study 3), with participants aged 18 to 20, psychometrically identified as psychosis-prone, scored an average of 22.26 on the ASI ($SD = 5.40$). This wide variability in ASI scores, emphasizes rightly the importance of separating transitory psychotic experiences from their stabilization as prodromes of psychosis [54]. The same working group observed that participants in their first psychotic episode had a baseline mean of 14.50 points ($SD = 7.00$) [50]. Therefore, the ASI will depend strongly on when the process is evaluated, and may be useful combined with evaluation of ideas of reference and negative symptoms, thereby palliating some of the problems in this valuable instrument. Some authors have emphasized the importance of differentiating perceptive, cognitive and experiential aspects of aberrant salience [48]. Furthermore, we think the size of our study sample suggests the need for some amendments to the instrument, such as the persistence of indicators. The ASI could also show the overall changes in stimulus salience, characterizing an inclusion of novel stimuli or erroneous mental content [22] without clearly distinguishing better adapted salience from what is considered aberrant [33].

The hypothesis that scores would differ by diagnosis was partially confirmed. As predicted, the patients with active schizophrenia and bipolar disorders differed significantly from other patients, especially those with depressive disorders. This result is close to the one found by

Cicero et al. [28] (Study 4) in a forensic context. However, in this study, the differences were not present in all the comparisons, so aberrant salience may be a process mainly relevant to psychotic manifestations, although other diagnostic groups, such as somatoform and anxiety disorders also had high scores.

Neumann et al. [55] observed intermediate aberrant salience in a group of patients with anxiety, and therefore, these authors mention that it might not be a trait exclusive to schizophrenia, and discuss whether the ASI is not really related to motivational salience as described in psychotic disorders. Longitudinal analysis and the experience sampling method have highlighted the relationship between aberrant salience and negative affect (anxiety), where anxiety diminishes when delusional experiences are clarified [54,56]. Therefore, psychotic disorders already established would be characterized by a downward trend in the relationship between aberrant salience and anxiety.

Therefore, this requires further research. Although the participants in the group of patients were evaluated at the time they requested clinical help, the scores on the ASI were generally high, much more than would be expectable according to more classic references of the delusional mood (aberrant salience) as a step previous to crystallization of delusion [7,21,31]. The studies by Pelizza et al. [54] and Scazza et al. [50] also suggest that average aberrant salience is very high during the first psychotic episode, so it is possible that the decrease in aberrant salience is slow and depends on other processes, for example, as mentioned, lessening of emotional states as psychotic symptoms stabilize.

Summarizing, this study validated the Aberrant Salience Inventory (ASI) in Spanish for adult and clinical populations. It is an important instrument for evaluating a complex process related to abnormal motivation in the context of the development of schizophrenia. As mentioned, it may not be absent in other pathological processes, although not as intense or more temporary, so it is of interest to add and differentiate resources that enable analysis, along with aberrant salience, of alterations in self-experience [57]. It remains to be elucidated whether these two processes refer to state or trait [22], respectively, and improve the motivational changes that best represent adaptive salience, anomalous or aberrant salience. We propose that a change in the dichotomous answer format to a Likert format be explored, as was originally done in some of the original ASI studies [28].

This study has a series of limitations that should be considered. In the first place, it is a cross-sectional study focused on group comparison, so these results should be generalized with caution. Only a prospective study would enable definitive confirmation of the onset of aberrant salience and when, whether it is connected to ideas of reference, and finally, ends with the crystallization of delusion. Nevertheless, the large samples of different groups representing different ages is a strength of the study. In the second place, several of the instruments used are self-reported, so they contain a bias which is hard to control, although validated instruments with psychometric guarantees were used. As highlighted, the main measure of aberrant salience was made with a self-report, and these results still need to be compared with measures that converge on the analysis of this process [48]. One important question has to do with negative symptomatology, which was not analyzed, and could provide clues to aberrant salience [58], keeping in mind that in the psychotic process, these negative symptoms are usually the first to begin. Finally, different clinical stages (risk, first episodes, remission) need to be analyzed to corroborate the changes expected in aberrant salience, as well as monitoring onset, course and treatment [50,56], especially in patients with psychotic disorders, so the role of aberrant salience can be securely established and its relationship with altered self-experience can be disentangled.

Declaration of Competing Interest

None.

Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.comppsych.2022.152343.

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