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Factor mixture analysis of paranoia in young people

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Abstract

Background Paranoid thoughts are relatively common in the general population and can increase the risk of developing mental health conditions. In this study, we investigate the latent structure of paranoia in a sample of young people.

Methods Cross-sectional survey; 243 undergraduate students (males: 44.9%) aged 24.3 years (SD 3.5). The participants completed the Green et al. Paranoid Thought Scales GPTS, a 32-item scale assessing ideas of social reference and persecution; the 12-item General Health Questionnaire (GHQ-12), and the 74-item Schizotypal Personality Questionnaire (SPQ). Confirmatory factor analysis (CFA) was used to confirm the two-factor structure of the GPTS. Factor mixture modeling analysis (FMMA) was applied to map the best combination of factors and latent classes of paranoia.

Results The GPTS showed excellent internal reliability and test–retest stability. Convergent validity was good, with stronger links with measures of ideas of reference and of suspiciousness than with other measures of psychosis–proneness. CFA showed excellent fit for the two-factor solution. FMMA retrieved a three-class solution with 176 subjects (72.5%) assigned to a baseline class, 54 (22.2%) to a "suspicious and mistrustful" class, and 13 (5.3%) to a "paranoid thinking" class. Compared to the baseline class, the other two classes had a higher risk of psychological distress and psychosis–proneness.

Conclusions The latent structure of paranoid thinking in young people appears dimensional. Although caution is advised when generalizing from studies on college students, screening for paranoid ideation in young people who complain about psychological distress might prove useful to prevent the development of severe and potentially debilitating conditions.

Keywords Paranoid thinking · Paranoia · Psychosis · Screening · Schizotypy · Youth

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Introduction

Paranoid ideation is typically observed in patients diagnosed with psychosis, but it can also be found in non-clinical populations [22, 39, 41, 47]. Paranoid thinking is related to feelings of threat to one's physical and psychosocial identity [26] and paranoid individuals have a tendency to think that harm is imminent [23].

Several studies describe paranoia across a continuum of severity (see reviews by Bentall et al. [7], Freeman [26], and Garety et al. [28]), and there is evidence that paranoid thinking can be widespread in the general population [15, 30, 64].

Theories have proposed that paranoid ideation is a human heuristic used to deal with uncertainty during stressful situations [57]. From this point of view, paranoid thinking might be considered as an adaptive evolutionary strategy protecting against threats. When threat is overestimated this mechanism becomes maladaptive and the chances increase that a neutral social event is perceived as dangerous [37, 38]. Paranoid

thinking was also found to be sensitive to tasks that manipulate emotions [42, 46], and this supports the hypothesis that it is more of a heuristic thinking style than a fixed process of information processing.

To date, one of the most widely used tools to assess paranoid thoughts in both clinical and non-clinical groups is the Green et al. Paranoid Thought Scales (GPTS; [30]). The GPTS is a self-assessment scale measuring ideas of reference (Part A) and of persecution (Part B), where each dimension is measured by a 16-item Likert scale. The GPTS has been used in over 100 studies internationally. It has excellent internal consistency (> 0.90) and validity for both clinical and non-clinical groups [30, 36].

This study was set out to investigate the prevalence of paranoid thinking in a sample of first-year college students, a population at a higher risk of mental distress due to new pressures in the academic setting [31, 34]. This study also intends to contribute to the psychometric validation of the Italian GPTS translation, by establishing its test–retest reliability and confirming its factorial structure.

The main aim of this study is to investigate the latent dimension of paranoia. Evidence collected so far supports a dimensional distribution of paranoid thinking in the general population, with pathological paranoia being at the extreme of this distribution [25]. An opposite view assumes that paranoid thinking articulates in hierarchically arranged subclasses. These different subclasses of paranoid thinking might be differentially related to psychological distress, with some classes being more likely to elicit distress and uneasiness than others. As proposed by Bebbington et al. [4], our hypothesis was that as paranoid thoughts increase, the recruitment of rarer and odder ideas increases as well, thus resulting in a hierarchy of paranoid thoughts dominated by mistrust, self-reference, and suspiciousness up to more severe and distorted ideas of persecution. We expected the extreme end of this hierarchy of paranoid thinking to be related to indicators of psychological distress and psychosis–proneness. Factor mixture modeling analysis (FMMA) was considered the best statistical technique to analyze this hypothesis, since FMMA allows relating the factor structure of the scale to the class structure. FMMA captures the role of both continuous and categorical latent variables, since it allows modeling several dimensions of paranoia across different classes of groups of people who may be homogeneous within each class but heterogeneous across classes depending on their scores on the dimensions of paranoia. FMMA goes beyond the limitations of the Latent Class Analysis, which fails to account for individual differences among latent continuous dimensions within classes.

Methods

The institutional review board (IRB) approved the study protocol in accordance with the guidelines of the 1995 Declaration of Helsinki and subsequent revisions [77].

Participants

Young adults attending the University of Cagliari were invited to take part in the study. The undergraduate sample was recruited via a snowball procedure. Participants were asked to complete an assessment booklet and help recruiting further participants among their colleagues. Recruiters asked initial participants, after completing the booklet with the questionnaires, to recruit further participants among their friends and acquaintances, provided that they were enrolled at the University; in turn, the latter were asked to recruit other potential participants, and so on. This method is designed to avoid self-selection bias occurring when few researchers are responsible for recruitment [71].

Out of 31,729 potential candidates among those attending university over the study period we approached 327 people. The targeted sample size was 300, chosen size thought to keep the error chance at its lowest (i.e., 5%) given the population, in the worst-case scenario of uncertainty in accuracy (i.e., 50%). Of all the students who returned the questionnaire, 13 only completed it partially and were excluded because of missing data on age or gender, or on some items in two or more questionnaires. The overall participation rate was 74%, i.e., 243 out of the 327 initial participants (see Flowchart in the "Appendix"). With a sample size of 243, the confidence interval of error in responding was 6.3%; therefore, having a smaller sample than the initial target was acceptable (calculation was done with the MaCorr sample size calculator, see http://www.macorr.com/sample-size-calculator.htm).

Participation was voluntary and with no compensation. All participants provided informed consent.

Those who refused to take part in the survey did not sign the informed consent. As per the protocol approved by the IRB, we could not record any information about those who did not sign the informed consent.

Measures

For the purpose of this study, the following measures were considered: the GPTS [30]; the 12-item General Health Questionnaire (GHQ-12; [29, 56]); and the Schizotypal Personality Questionnaire (SPQ [62]).

The GPTS is 32-item self-report measure of paranoid thinking; it includes 16 items reflecting ideas of social

reference and 16 items reflecting ideas of persecution. Each item is rated on a five-point Likert scale from 1 (not at all) to 5 (totally). In the questionnaire, the self-reference construct is aligned to the definition provided by Startup and Startup [73]: "The person holds the belief that some neutral event has special personal significance/refers to them personally by means of observation or communication by another". The concept of persecution aligns well with the model of Freeman and Garety [21], i.e., individuals are thought to hold persecutory beliefs when they believe that harm is occurring, or is going to occur to them and that the potential persecutor has the intention to cause that harm. The two subscales can be used separately or can be totaled to get the overall score. In both subscales, total scores can range from 16 to 80 with higher scores reflecting higher levels of paranoia.

Standard procedures were followed to prepare the Italian version of the GPTS [32]. Two authors (AP and MC) translated the original English version of the GPTS, as in Green et al. [30], into Italian. This Italian version was then back-translated into English and translation accuracy was confirmed by an independent English-speaking translator and further optimized with the help of a third author (AR).

The GHQ-12 is a screening tool aimed at identifying people who may be experiencing a mental health condition [29]. With a standard dichotomized scoring system, scores equal or above 4 are considered indicative of clinically relevant psychological distress (i.e., needing clinical attention) [56]. Patients with psychosis tend to score higher on the GHQ-12 than patients with anxiety or depressive disorders, and scores equal or above 6 better differentiate people diagnosed with psychosis from healthy people than the usual threshold of 4 [59].

The SPQ is a 74-item self-report scale using true/false items [62]. It was developed to assess schizotypal personality disorder according to the Diagnostic and Statistical Manual of Mental Disorders, Revised Third Edition (DSM-III-R; American Psychiatric Association, [2]). The current 5th edition of the DSM has kept the same description of the schizotypal personality disorder as in DSM-III-R [3]. Thus, the SPQ can be still used to generate a profile of "psychometric high risk" for the detection of individuals at a heightened risk for psychosis [44].

Usually, the SPQ is considered to measure a multidimensional construct, including a cognitive–perceptual deficits domain (ideas of reference, odd beliefs or magical thinking, unusual perceptual experiences, and paranoid ideation/suspiciousness subscales); an interpersonal deficits domain (excessive social anxiety, no close friends, constricted affect, and paranoid ideation/suspiciousness subscales); and a disorganized behavior domain (odd or eccentric behavior and odd speech subscales) [62, 63]. The validated Italian version of the SPQ was used for this study [19].

General socio-demographic information was also collected including data on age, gender, and socio-economic status. As a measure of socio-economic status, we used the highest achieved level of parental education [27].

Statistics

Overall, 256 participants took part in the study, and 243 participants completed the data on the measures of interest. An independent research assistant rechecked the data after they were entered: error rates were less than 1% and all were corrected on the basis of the questionnaires.

All data were coded and analyzed using the Statistical Package for Social Sciences (SPSS), version 20, and with dedicated packages running in R [60]. All tests were two-tailed. Due to multiple testing, significance threshold was set at $p < 0.005$. According to Bayesian interpretations, this threshold has the greatest chance of suggesting evidence against the null hypothesis [40].

Scales reliability was measured by Cronbach's alpha to favor comparison with the past studies. For group comparisons, reliability values of 0.70 are considered satisfactory; when dealing with subscales derived from a single questionnaire, values around 0.60 are considered acceptable [54]. Test–retest stability was assessed with the intraclass correlation coefficient (ICC), with 95% confidence of Interval (CI). The ICC is dimensionless statistics that describes the reproducibility of repeated measurements in the same population [9]. Sample sizes between 15 and 160 were suggested for two measurements with expected ICC values ranging from 0.60 (acceptable) to 0.90 (excellent). A sample size of 120 subjects was a reasonable compromise between the available resources (6 independent recruiters, so $120 = 20$ per recruiter) and the need to take into account the number of items (around 4 subjects per item; see [55]). Thus, test–retest reliability was evaluated in a subgroup of 120 randomly selected participants, who were invited to fill in the GPTS 30 days after the first administration. Follow-up completion rate was 95% for the test–retest reliability sample with 6 participants not returning the booklet.

The Bland and Altman [8] method was used, too, to assess agreement at retest.

Confirmatory factor analysis of the GPTS

The GPTS is assumed to measure ideas of reference and ideas of persecution. This two-factor structure has been replicated in independent samples [36]. We, therefore, tested the factorial structure of the GPTS with confirmatory factor analysis (CFA) for these two factors. The two-factor model was compared to a one-dimensional model, which assumes that all items tap into a single dimension of "paranoid

thinking" to prove the superiority of the two-factor model over the more parsimonious one.

CFA was carried out with the *lavaan* package [65] running in R [60].

Mardia's test [49] revealed violation of multivariate normality in the data: skew = 44652.85, $p < 0.0001$; kurtosis = 233.48, $p < 0.0001$. Therefore, the diagonally weighted least squares (DWLS) estimator was used. The *DWLS* approach automatically uses the WLS estimator with *polychoric* correlations as input to create the asymptotic covariance matrix. The DWLS estimator is known to have a fairly good control of Type I error rates with sample sizes as small as 200 [18]. Parameters for fit estimation were: the Chi square, the comparative fit index (CFI), the root mean square error of approximation (RMSEA), and the standardized root mean square residual (SRMR). McDonald's omega was also calculated, as estimated by the model [51]. McDonald's omega is a reliability coefficient, with the advantage of taking into account the strength of the combination of elements and constructs, as well as the specific measurement errors of each element. RMSEA values of 0.08 or lower, SRMR values of 0.09 or lower, CFI values of 0.90 or higher, and McDonald's omega around 0.90 are considered acceptable [10, 35]. Model identification was verified according to the method by Bekker et al. [5], based on Wald's Rank Rule (see details in [58]). Models were compared on the basis of the fit indexes, the explained variance per item, and with the Satorra–Bentler-scaled Chi-square difference test [66].

Factor mixture modeling analysis

FMMA combines common factor models with latent class analysis to explore unobserved population heterogeneity [48]. In FMMA, continuous latent variables are used to explain the variation and co-variation in a set of observed items, while the categorical latent variable represents heterogeneity at the factor level [70]. Analysis was carried out with the "FactMixtAnalysis" [76] and the "fmaTools" [50] packages running in R [60].

We estimated 2 to 5 classes, since the use of more classes would have made the interpretation of the model too complicated, and would have required to estimate an excessive amount of parameters (more than what would be tolerated based on sample size). Models were compared on the basis of the following information criteria: the Akaike's information criterion (AIC; [1]) and its small-sample-size corrected version (CAIC; [11]); the Bayesian information criterion (BIC; [69]), and its small-sample-size adjusted version (ABIC; [11]). Preference was given to the models with the lowest information criteria value [67]. By generalizing an oft-used rule of thumb, when the difference (delta) between information criteria values is equal to or below 2, the models can be considered equivalent; when the difference is higher than 10, the difference

results strong and the model with the lowest information criteria value should be preferred [11]. Participants were assigned to the latent class they had the highest probability of belonging to (average probabilities per class ≥ 85%).

Predictive ability of the GPTS via multinomial logistic regression

According to Raine [62], no more than a half of those scoring at the top 10% of SPQ would receive a diagnosis of schizotypal personality disorder. We assumed that those scoring at the top 10 percent of SPQ were more likely to have a schizotypal personality disorder, thus being at risk of psychosis, when they also manifested intense psychological distress. Therefore, participants were identified as being high at-risk mental states (HARMS) for psychosis when they scored above the cutoff ≥ 6 on the GHQ-12 [59] and scored in the top tenth percentile on the SPQ [62].

Multinomial logistic regression was used to assess the association between GPST class membership and being at high risk of psychosis, taking into account demographic data (i.e., gender and age). Fit for the model was assessed with the Likelihood ratio test and the McFadden [pseudo]R^2, which was used as a measure of explained variance, with values from 0.20 to 0.40 indicating good model fit [52]. Adjusted odds ratio (OR), with 95% confidence interval (95% CI), and estimated Wald test's p were reported for each predictor.

Results

The sample counted 109 men (44.9%) and 134 women (55.1%). Mean age of participants was 24 years (SD = 3.6). Gender proportion was roughly similar to the proportion in the population attending university in the study period (41% men versus 59% women). Mean age in the sample was close to the mean age in the population from which the sample was extracted (26 years old). Two participants were married (0.8%) and 119 reported to be in a stable relationship (49%). The participants whose parents had a high school diploma were 106 (44%), while the participants whose parents had a university degree or a higher qualification were 33 (13%).

Reliability

Internal coherence was acceptable for all scales and subscales (Table 1).

Test–retest reliability for the GPTS, as measured by ICC, was 0.90 (95% CI 0.87–0.93) for the "ideas of reference" subscale, and 0.94 (0.92–0.95) for the "ideas of persecution" subscale.

By plotting the differences and the means of the two assessments in the Bland–Altman plot, only eight cases

Table 1 Mean scores on the measures of psychopathology used in the study (sample $n = 243$)

| Measures of psychopathology	Cronbach'	Mean (SD)	Skewness	Kurtosis
GPTS				
Ideas of reference (iR)	0.88	22.8 (7.9)	1.73	2.97
Ideas of persecution (iP)	0.93	19.8 (7.2)	2.58	6.67
GHQ-12	0.84	3.4 (3.0)	0.91	− 0.03
SPQ subscales				
Ideas of reference (IR)	0.77	2.2 (2.2)	0.95	0.12
Excessive social anxiety (SA)	0.74	2.6 (2.1)	0.75	− 0.12
Odd beliefs or magical thinking (MT)	0.64	0.9 (1.3)	1.82	3.74
Unusual perceptual experiences (UPE)	0.63	1.3 (1.5)	1.49	2.52
Odd or eccentric behavior (OB)	0.78	1.1 (1.6)	1.74	2.75
No close friend (NCF)	0.61	1.1 (1.4)	1.55	1.79
Odd speech (OS)	0.80	2.7 (2.4)	0.84	− 0.13
Constricted affect (CA)	0.59	1.6 (1.5)	0.88	0.41
Suspiciousness (S)	0.75	2.4 (2.0)	0.88	0.02
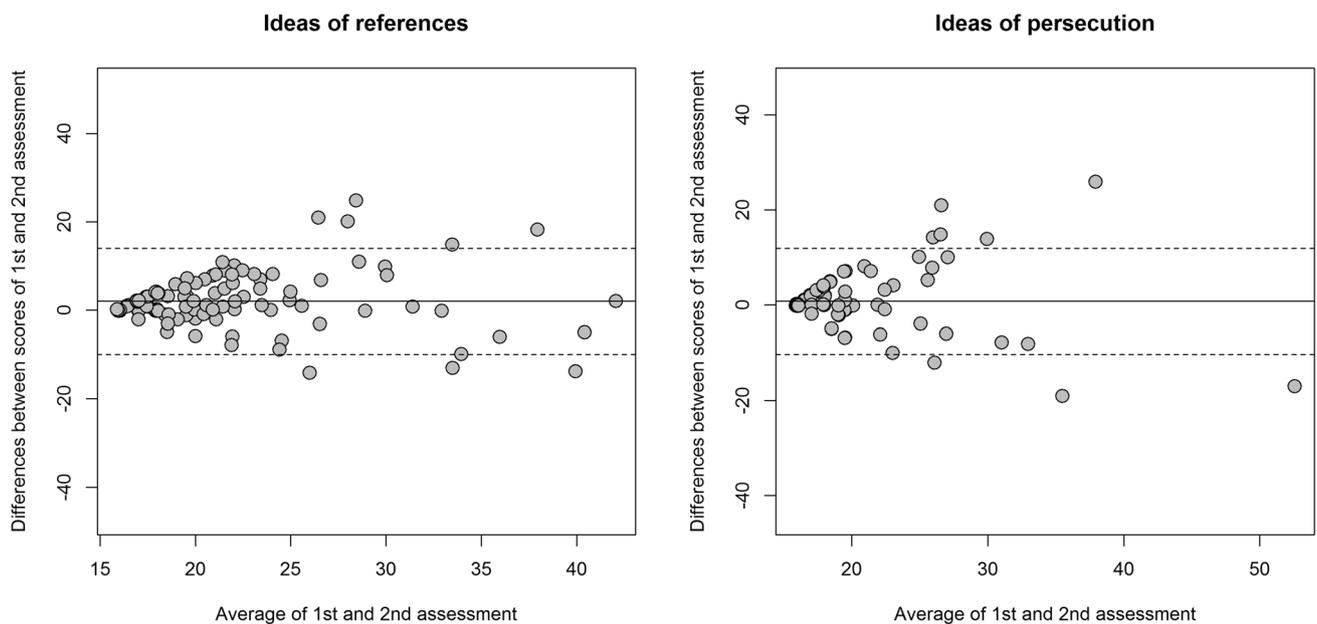
Fig. 1 Bland–Altman plot of GPTS test and retest assessment ($n = 114$). The horizontal axis shows the mean of the two measurements ([test + retest]/2), while the vertical axis reports the absolute difference between the test and the retest (retest – test). The majority of values is expected to fall within 95% of the limits of agreement (average difference ± 1.96 standard deviation of the difference)

out of 114 (7%) were outside the upper and lower limits of agreement for both the "ideas of reference" and the "ideas of persecution" subscales of the GPTS (Fig. 1).

Descriptive statistics

The scores on the two subscales of "ideas of reference" and "ideas of persecution" showed some degree of asymmetry (1.73 and 2.58, respectively), and high kurtosis (2.8 and 6.4). Overall, scores on both subscales had a leptokurtic, right skewed distribution, with most values concentrated left of the mean, i.e., on the low pathology side (Figure A1 in the appendix).

Only a minority endorsed the items at the highest scores (4/5). The scores 4 and 5 were more frequently assigned to item 7 ("I believed that certain people were not what they seemed"), item 8 ("People talking about me behind my back upset me"), and item 11 ("Certain people were hostile towards me personally") in the "ideas of reference" scale; to item 15 ("People have been hostile towards me on purpose"), item 10 ("I couldn't stop thinking about people wanting to confuse me"), and item 5 ("I was sure certain people did things

to annoy me") in the "ideas of persecution" scale (details in "Appendix").

Association of the GPTS with measures of psychological distress and schizotypy

Gender, age and socio-economic status were not associated to the scores on the GPTS, the GHQ-12 or the SPQ, but for a modest negative correlation between age and the "excessive social anxiety" subscale of the SPQ (Spearman's rho = 0.21, $p = 0.001$).

Scores on the GPTS were related to measures of schizotypy, with stronger links with measures of ideas of reference and of suspiciousness than with other measures of psychopathology (Table 2).

Steiger's z test had $p < 0.005$ in all comparisons in the "ideas of reference" scale, while in the "ideas of persecution" scale the differences were less compelling (depending on the comparison, Steiger's z test had $p < 0.05$ or was not statistically significant).

Confirmatory factor analysis of the two-factor structure of the GPTS

The fit of the model was excellent for the one-dimensional model: $\chi^2 = 330.24$, df = 464, $p = 1.00$; CFI = 1.00; RMSEA = 0.0 (95% CI 0.0–0.0); SRMR = 0.108. The model was correctly identified according to Wald's rule (rank of the Jacobian matrix = 64; number of columns in the matrix = 64).

The fit of the model was excellent also for the two-factor solution: $\chi^2 = 246.71$, $df = 463$, $p = 1.00$; CFI = 1.00;

RMSEA = 0.0 (95% CI 0.0–0.0); SRMR = 0.092 (Wald's rule: rank of the Jacobian matrix = 65; number of columns in the matrix = 65).

Albeit differences in fit were minimal, the two-factor model was superior to the one-dimensional model: Satorra $\chi^2 = 83.5$, $df = 1$, $p < 0.0001$. The explained variance per item was greater, on average, in the two-factor model than in the one-dimensional model: 38.6% versus 33.1%. The two-factor model was, therefore, preferred, because it was congruent with the a-priori design of the scale, and because of its statistical superiority to the alternative model.

McDonald's omega was 0.88 for the "ideas of references" scale, and 0.92 for the "ideas of persecution" scale. Standardized factor loading was good (> 0.55) or excellent (> 0.63) for most items, with values between 0.40 and 0.50 (see details in "Appendix").

Factor mixture analysis of GPTS scores

FMMA on a two-factor model retrieved a three-class solution on the basis of the information criteria.

In particular, with respect to the four-class solution, the delta for the three-class solution was higher than 10 on all information criteria (AIC: − 23.10; CAIC: − 50.07; BIC: − 44.07; ABIC: − 25.5). The five-class solution had higher values than the three-class solution for the CAIC (− 52.49) and the BIC (− 40.49), while no relevant delta was found for the AIC (1.43) and the ABIC (− 2.49). The three-class solution was judged as preferable for parsimony (see Figure 4 in the "Appendix").

Table 2 Inter-correlation among the measures of psychopathology used in the study (sample $n = 243$)

Measures of psychopathology[a]	iR	iP	GHQ-12	IR	SA	MT	UPE	OB	NCF	OS	CA
GPTS											
Ideas of reference (iR)											
Ideas of persecution (iP)	0.71*										
GHQ-12	0.31*	0.23*									
SPQ subscales											
Ideas of reference (IR)	0.59*	0.45*	0.35*								
Excessive social anxiety (SA)	0.35*	0.24*	0.30*	0.37*							
Odd beliefs or magical thinking (MT)	0.36*	0.27*	0.25*	0.45*	0.32*						
Unusual perceptual experiences (UPE)	0.40*	0.32*	0.26*	0.46*	0.25*	0.37*					
Odd or eccentric behavior (OB)	0.39*	0.32*	0.23*	0.47*	0.29*	0.36*	0.30*				
No close friend (NCF)	0.27*	0.17	0.08	0.26*	0.38*	0.14	0.09	0.25*			
Odd speech (OS)	0.43*	0.29*	0.24*	0.42*	0.39*	0.27*	0.36*	0.49*	0.33*		
Constricted affect (CA)	0.28*	0.15	0.15	0.26*	0.41*	0.17	0.18	0.26*	0.50*	0.38*	
Suspiciousness (S)	0.57*	0.37*	0.40*	0.55*	0.42*	0.35*	0.32*	0.36*	0.33*	0.38*	0.41*

* Spearman's rho $p < 0.0001$

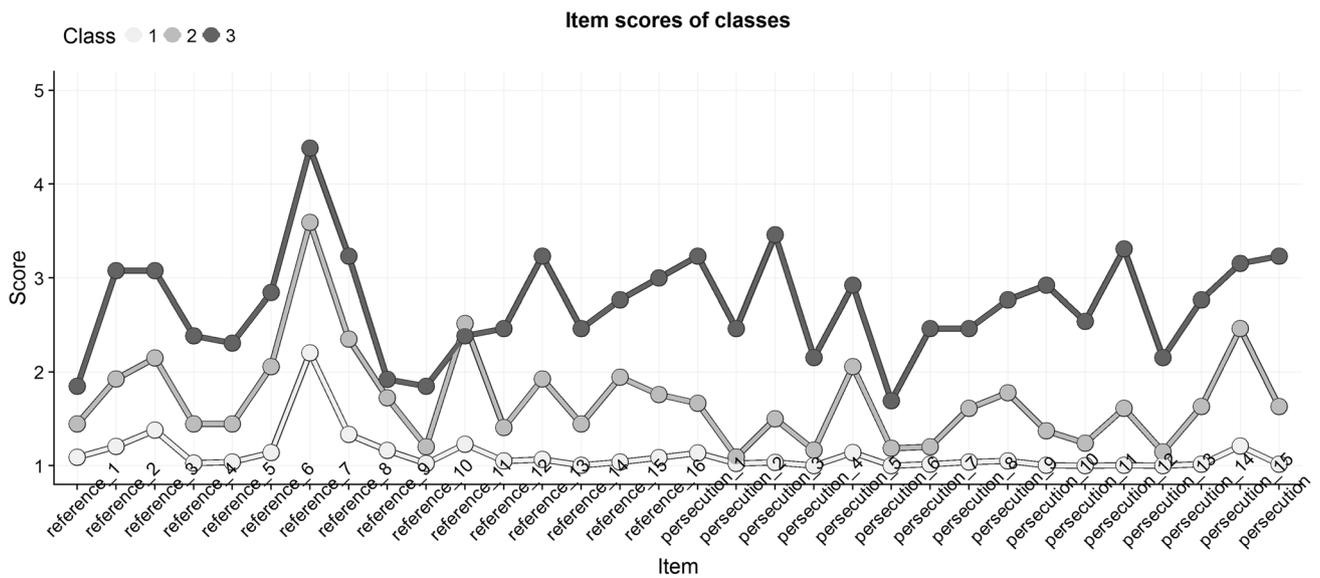[a] Abbreviation of the subscales (e.g., iR) is explained in the first column

Fig. 2 Profile plot for the factor mixture modeling latent class analysis of the two scales of the GPTS, ideas of reference and ideas of persecution, each counting 16 items. The *Y*-axis represents the class-specific mean scores as proportions of the maximum score for the indicator. The *X*-axis contains the 32-item profile of the GPTS

In the sample, 176 subjects (72.5%) were assigned to the first class, 54 (22.2%) to the second class, and 13 (5.3%) to the third class. The three classes corresponded to a baseline class (the first class) of people who denied the occurrence of ideas of reference or persecution; an intermediate class of suspicious and mistrustful persons, and a "paranoid thinking" class including the minority of people who admitted the occurrence of ideas of reference or persecution with the highest rate (Fig. 2).

Predictive ability of the GPTS via multinomial logistic regression

In the sample, 59 participants (24.3%) scored ≥ 6 on the GHQ-12; 25 participants (10.3%) scored in the top tenth percentile on the SPQ, and 10 participants (4.1%) were identified as HARMS individuals (i.e., those scoring both above the cutoff ≥ 6 on the GHQ-12 and in the top tenth percentile on the SPQ).

Gender and age were not statistically related to HARMS cases. Compared to the baseline class, both the "suspicious and mistrustful" and the "paranoid thinking" classes were related to HARMS cases, but with a wide confidence interval (Table 3).

Overall, the model had a good fit (Likelihood ratio test: $\chi^2 = -41.69$; $df = 1$; $p < 0.0001$; McFadden's pseudo-$R^2 = 0.27$), and high accuracy (0.95; 95% CI 0.92–0.98).

Table 3 Association between latent classes of GPTS and HARMS case, taking into account gender and age

All data: *n* (%)	No risk of psychosis $n = 233$ (95.9%)	HARMS case $n = 10$ (4.1%)	OR (95% CI)
Gender			
Men	102 (43.8%)	7 (70.0%)	1
Women	131 (56.2%)	3 (30.0%)	0.25 (0.05–1.15); $p = 0.0758$
Age			
19–24 years old	131 (56.2)	6 (60.0%)	1
25 years old and older	102 (43.8)	4 (40.0%)	0.90 (0.22–3.76); $p = 0.8915$
GPTS classes			
Baseline class	175 (99.4%)	1 (0.6%)	1
Suspicious and mistrustful class	48 (88.9%)	6 (11.1%)	28.4 (3.22–250.3); $p = 0.0025$
Paranoid thinking class	10 (76.9%)	3 (23.1%)	42.6 (3.89–465.7); $p = 0.0021$

Discussion

Our results showed that the Italian version of the GPTS has good psychometric properties. Reliability conceived as both internal coherence and test–retest stability, was optimal for the "ideas of reference" and "ideas of persecution" scales of the GPTS. The original factorial structure was confirmed, with extremely good fit of the model with two separate but correlated factors. Convergent and divergent validity was also confirmed, with stronger links with measures of self-reference and suspiciousness compared to other dimensions of schizotypy. Indeed, there was a gradient of responses across the GPTS, with greater endorsement of items pertaining to ideas of mistrust, self-reference and suspiciousness than of items pertaining to overt hostility from others and ideas of persecution. This suggests that these items may capture less common experiences and may have a larger influence on mental health problems.

However, the hypothesis of a differential gradient of responses across the sample was not confirmed by the FMMA. The GPTS distributes linearly across different levels of severity, from scarce paranoid thinking to increased propensity to mistrust and suspiciousness, to a limited group of people reporting paranoid thinking resembling clinical paranoia. This structure of paranoid ideation is congruent with the hypothesis that paranoid thinking is dimensionally distributed, with paranoid delusions sitting at the extreme end of the continuum [25].

A dimensional distribution of paranoid thinking in the population suggests that there may be some shared mechanisms behind its expression in clinical and non-clinical populations [14]. A possible mechanism underlying all types of suspicious thinking might consider paranoia as a human heuristic used to deal with uncertainty during stressful situations [57]. While this mechanism may provide fast decisions it may also, depending on the circumstances, generate a high rate of false positives [37, 38].

In this study both classes of intermediate and high paranoid thinking were related to a proxy of high-risk mental states for psychosis, which suggests that even moderate paranoid thinking—i.e., the kind that could be socially acceptable—may represent a risk factor for psychopathology. In the past studies, conspiracy beliefs within the spectrum of mistrust and suspiciousness were found to be associated with lower levels of physical and psychological wellbeing, and a higher chance of meeting criteria for a psychiatric disorder or reporting suicide ideation (e.g., Freeman and Bentall [20]). Thus, even slight paranoid ideation deserves monitoring on a clinical ground and it is worthy of a more in-depth investigation on epidemiological and research grounds for its potentially harmful consequences on human health.

A recent study based on network analysis [6] confirmed a central role for worrying in the establishment and maintenance of paranoid thinking [23].

Worry may increase anxiety and depression which, in turn, may elicit paranoid thinking [24]. Early intervention may be particularly indicated for people presenting with paranoid ideation and symptoms of anxiety or depression. Low self-esteem has also been consistently related to the occurrence of paranoid ideation [43], and may be a target for intervention, too [75]. Since there is evidence that paranoid ideation fluctuates on a day-to-day basis [74], it may be possible and advisable to monitor its fluctuations with mobile devices, which may also be used to deliver intervention to young people [16, 17].

Strengths and limitations of the study

The study included a sample that was comparable—by age and gender proportion—to the population from which it was extracted. Because of the recruitment method (snowball procedure), we were unable to control for aspects such as the type of department attended, the status of commuter or local resident, and so on. Although our aim was minimizing the confidence interval of error in responding, we cannot assure full representativeness of the sample with respect to the reference population (first-year college students in the source university or in Italy). Indeed, concerns have been raised on the broad generalizability of studies that are carried out in samples of college students. College students form a very specific group of people because of age range and socio-economic and educational background. For these reasons, the range of paranoia in the general population might be greater than what is observed in the college sample. The distribution of paranoid thinking we found in this study should be considered a lower bound of what can be found in the general population. As a matter of fact, when tested across 59 countries and 12 personality and attitudinal variables, students were found to be on average as heterogeneous as the general public both between and within countries [33]. Moreover, college students may be more forthcoming in reporting unusual or otherwise uncommon subjective experiences when compared to people from the general population. Nevertheless, when corrected by age, such differences in reporting were found to disappear [45]. Some simulation studies also offer statistical evidence that the situations when recourse to college students may constrain experimental inferences are relatively limited [13]. Ultimately, only the explicit comparison between college students and people from the general population on the model we tested can provide evidence about the generalizability or not of these findings.

The exclusive use of self-report tools might have introduced some bias in responding. Nevertheless, self-report measures allow the enrollment of large samples, and the

guarantee of anonymity might have made participants more forthcoming when filling in the questionnaires. We did not conduct a follow-up to further evaluate people identified as being at potential (psychometric) risk with dedicated interviews such as the Comprehensive Assessment for At-Risk Mental States [CAARMS], the Structured Interview for Prodromal Syndromes/Scale of Prodromal Symptoms [SIPS/SOPS], or the Structured Interview for Prodromal Schizophrenia Proneness Instrument-Adult [SPI-A] [68]. Indeed, the findings of this investigation about the predictive ability of the GPTS need to be corroborated by further studies using a standardized interview as a gold standard. It should be noted that participants were undergraduates still attending university courses; thus, it is unlikely that they had a full-blown episode of psychosis at the time of the study. Moreover, being the participants sampled from college students, the results cannot be immediately generalizable to all the population aged 19–34 years.

Conclusions

This study provided evidence for the good reliability, and good convergent, divergent, and predictive validity of the Italian version of the GPTS. The study also confirmed that ideas of references can be separated from ideas of persecution, with ideas of references being probably related to abnormal salience [12, 61] and referential thinking [53, 72], and ideas of persecution being likely to lay in continuity with beliefs and feelings of threat to physical and psychosocial identity [23, 26]. The latent structure of paranoid thinking in young people appears dimensional, with only a minority endorsing items in the dimensions of ideas of references and of persecution at a high degree. There is a high risk of psychological distress among those who endorse items pertaining to minor paranoid thinking within a simply "suspicious and mistrustful" class. Monitoring paranoid ideation is indicated, particularly in those who express it in association with symptoms of anxiety, depression, or low self-esteem, as this may allow early identification and treatment for those at risk of developing psychosis.

Compliance with ethical standards

Conflict of interest Authors declare that they have no conflict of interest.

Ethical approval The institutional review board approved the study protocol in accordance with the guidelines of the 1995 Declaration of Helsinki and their revisions.

Informed consent All participants provided informed consent. Participation was voluntary and with no compensation.

Appendix

See Table 4 and Figs. 3 and 4.
   Flowchart of recruitment

Population of young adults attending University during the study period
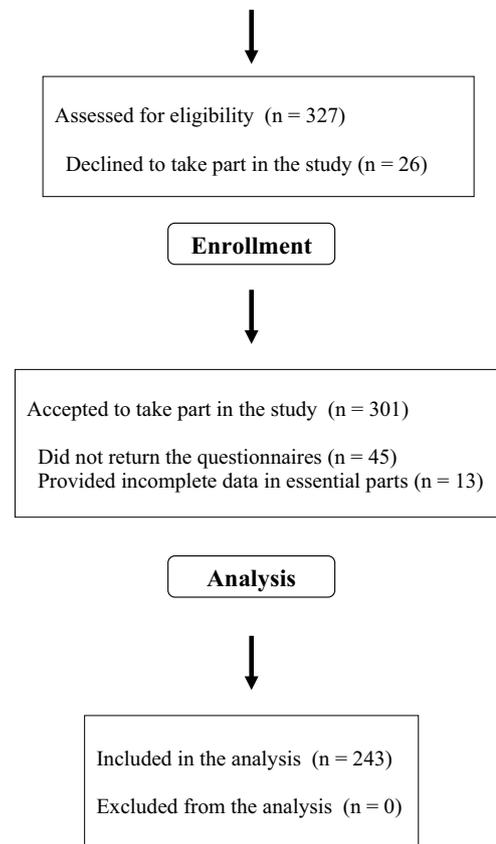University students: n = 31,729

↓

Assessed for eligibility (n = 327)

Declined to take part in the study (n = 26)

Enrollment

↓

Accepted to take part in the study (n = 301)

Did not return the questionnaires (n = 45)
Provided incomplete data in essential parts (n = 13)

Analysis

↓

Included in the analysis (n = 243)

Excluded from the analysis (n = 0)

Table 4 Distribution of scores and factor loading on the Green et al. paranoid thought scales GPTS

	Mean (SD)	N (%) score 4–5	Factor loading
Part A. Ideas of reference and social distrust			
1. I spent time thinking about friends gossiping about me	1.21 (0.49)	0 (0.0%)	0.469 *
2. I often heard people referring to me	1.47 (0.81)	9 (3.7%)	0.659 *
3. I have been upset by friends and colleagues judging me critically	1.64 (0.93)	11 (4.5%)	0.580 *
4. People definitely laughed at me behind my back	1.19 (0.57)	3 (1.2%)	0.638 *
5. I have been thinking a lot about people avoiding me	1.20 (0.58)	4 (1.6%)	0.548 *
6. People have been dropping hints for me	1.44 (0.96)	17 (7.0%)	0.534 *
7. I believed that certain people were not what they seemed	2.63 (1.35)	64 (26.3%)	0.634 *
8. People talking about me behind my back upset me	1.66 (1.04)	20 (8.2%)	0.631 *
9. I was convinced that people were singling me out	1.33 (0.68)	4 (1.6%)	0.420 *
10. I was certain that people have followed me	1.11 (0.43)	2 (0.8%)	0.437 *
11. Certain people were hostile towards me personally	1.58 (1.04)	20 (8.2%)	0.519 *
12. People have been checking up on me	1.21 (0.69)	9 (3.7%)	0.486 *
13. I was stressed out by people watching me	1.37 (0.87)	13 (5.3%)	0.677 *
14. I was frustrated by people laughing at me	1.18 (0.57)	2 (0.8%)	0.631 *
15. I was worried by people's undue interest in me	1.33 (0.82)	11 (4.5%)	0.667 *
16. It was hard to stop thinking about people talking about me behind my back	1.34 (0.80)	10 (4.1%)	0.622 *
Part B. Ideas of persecution			
1. Certain individuals have had it in for me	1.37 (0.77)	7 (2.8%)	0.712 *
2. I have definitely been persecuted	1.12 (0.53)	3 (1.2%)	0.457 *
3. People have intended me harm	1.27 (0.71)	8 (3.3%)	0.840 *
4. People wanted me to feel threatened, so they stared at me	1.10 (0.41)	1 (0.4%)	0.606 *
5. I was sure certain people did things to annoy me	1.44 (0.85)	11 (4.5%)	0.690 *
6. I was convinced there was a conspiracy against me	1.08 (0.32)	0 (0.0%)	0.542 *
7. I was sure someone wanted to hurt me	1.14 (0.56)	4 (1.6%)	0.481 *
8. I was distressed by people wanting to harm me in some way	1.24 (0.62)	4 (1.6%)	0.579 *
9. I was preoccupied with thoughts of people trying to upset me deliberately	1.30 (0.70)	4 (1.6%)	0.716 *
10. I couldn't stop thinking about people wanting to confuse me	1.19 (0.56)	15 (6.2%)	0.782 *
11. I was distressed by being persecuted	1.14 (0.51)	3 (1.2%)	0.637 *
12. I was annoyed because others wanted to deliberately upset me	1.26 (0.69)	7 (2.9%)	0.743 *
13. The thought that people were persecuting me played on my mind	1.09 (0.38)	1 (0.4%)	0.609 *
14. It was difficult to stop thinking about people wanting to make me feel bad	1.25 (0.66)	5 (2.0%)	0.683 *
15. People have been hostile towards me on purpose	1.59 (1.04)	21 (8.6%)	0.673 *
16. I was angry that someone wanted to hurt me	1.27 (0.74)	7 (2.8%)	0.724 *

*Wald statistic $p < 0.0001$

Fig. 3 Distribution of scores on the two scales of the GPTS and their inter-correlation. Ellipse, with confidence interval, is centered around the points that contribute the most to the correlation coefficient between the two scales
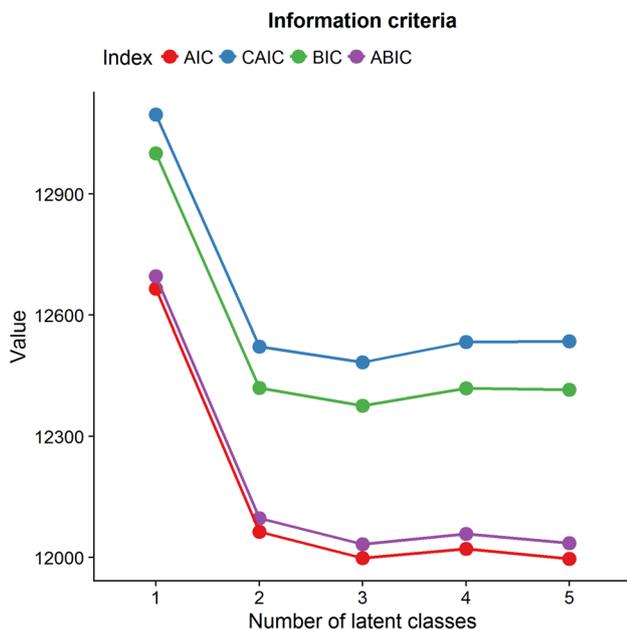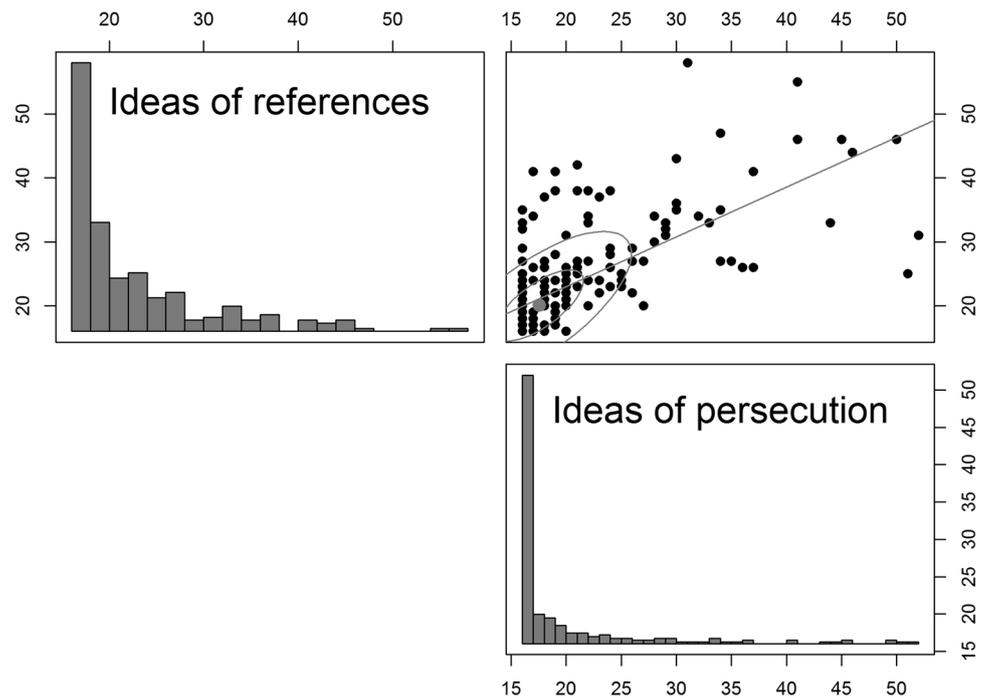

Fig. 4 Scatterplot of the values of information criteria by number of latent classes. The solution with the lowest value of the information criteria has to be preferred (in this case, the one with three classes)

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