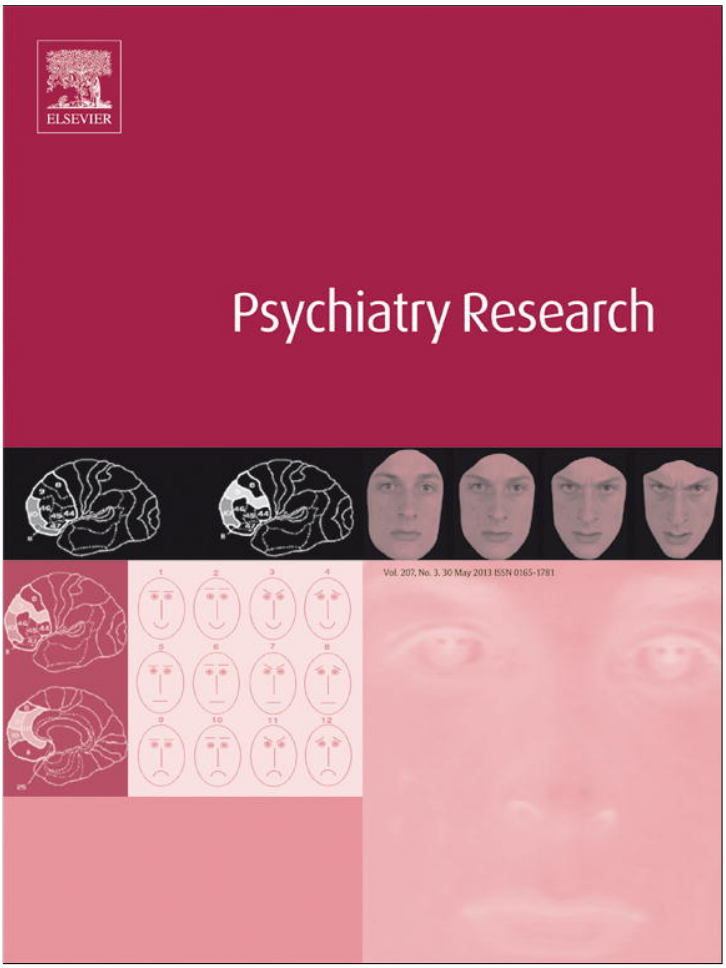

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Psychometric properties of Peters et al. Delusions Inventory-21 in adolescence

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ABSTRACT

We explored the psychometric properties of the Korean version of the Peters et al. Delusions Inventory-21 (PDI-21) and evaluated the item characteristics of the PDI-21 compared with the Magical Ideation Scale (MIS) in Korean community adolescents. Survey participants comprised 310 Year 10 students who were assessed with the following instruments: the PDI-21, the MIS, the Schizotypal Personality Scale (STA) and the Symptom Checklist-90-R (SCL-90-R). The item characteristics of the PDI-21 and MIS were also explored using item response theory (IRT). The PDI-21 exhibited good internal consistency and demonstrated significant correlations with the MIS, STA and all subscale scores of the SCL-90-R, indicating psychological distress in adolescents with high PDI-21 scores. We also found through IRT analysis that the PDI-21 provides more information at the lower range and the MIS at the higher range of delusion proneness. Our findings suggest that the PDI-21 is an effective and reliable self-report measure for assessment of delusion proneness and that the PDI-21 and the MIS may be used complementarily to assess a broad range of delusion proneness among community adolescents.

1. Introduction

A large body of evidence supports the continuity of delusion-like experiences in the general population (Johns and van Os, 2001), while a recent meta-analysis showed that the median 1-year incidence of psychotic experiences in the general population is 3.1% (van Os et al., 2009). Furthermore, several studies have shown that the sub-threshold psychotic symptoms lead to an increased risk of psychotic disorders in both the general population (Poulton et al., 2000; Welham et al., 2009) and the treatment-seeking population (Cannon et al., 2008). Because adolescence seems to be a critical period for the emergence of psychotic symptoms (Walker and Bollini, 2002), psychotic like experiences during this period cannot be overlooked from the developmental perspective of psychotic disorders (Poulton et al., 2000). However, there have been suggestions that these so-called 'psychotic-like' experiences may possess only limited specificity (Meng et al., 2009) due to the frequency of identity problems, depersonalization experiences and irritability arising from the adaptation problems of this age group (Harrop and Trower, 2003).

Understanding the inherent characteristics of rating instruments is a prerequisite to conducting behavioral studies on adolescent populations. Several instruments have been developed to assess psychotic-like experiences in community adolescents (Fonseca-Pedrero et al., 2011; Kelleher et al., 2011). It is still disputed whether delusion proneness, as observed in community samples, is a variation of the 'psychoticism' dimension of personality (fully dimensional view) or a phenotypic expression of a schizotypal feature such as attenuated psychotic symptom (quasi-dimensional view) (Kim, 2004; Meehl, 1989). The Magical Ideation Scale (MIS) (Eckblad and Chapman, 1983) and the Peters et al. Delusions Inventory-40 (PDI-40) (Peters et al., 1999), based on Meehl's quasi-dimensional view of 'schizotypy' (Meehl, 1989), were originally developed to measure delusional thinking in the non-clinical population.

Abbreviations: ANOVAs, analysis of variances tests; IRT, item response theory; MIS, Magical Ideation Scale; PDI-21, Peters et al. Delusions Inventory-21; PDI-40, Peters et al. Delusions Inventory-40; STA, Schizotypal Personality Scale; SCL-90-R, Symptom Checklist-90-R

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The PDI-40 was designed to measure a wider range of delusion proneness in the general population, including delusions of reference, persecution, expansiveness, guilt, depersonalization, control and being controlled (Peters et al., 1999). Each item on the PDI-40 was softened by the insertion of 'as if' to ensure some endorsement in the general population (Peters et al., 1999). The Peters et al. Delusions Inventory-21 (PDI-21), which was also standardised by Peters et al. (2004), is an abbreviated version of the PDI-40 with 21 items. The PDI-21 is a self-report measure that assesses the presence of delusion proneness and its three dimensions: distress, preoccupation and conviction. The total Yes/No score for delusion proneness is derived by assigning one point to each item answered 'Yes' and 0 points to 'No' replies, and thus the maximum total Yes/No score is 21. In the case of a 'Yes' response, the three dimensions are additionally rated on a five-point Likert scale (1–5). The subscore of each dimension is obtained by summing up the scores for that dimension from all 21 items (range: 0–105) (Peters et al., 2004).

The aim of this study was to investigate the psychometric properties of the Korean version of the PDI-21 and to explore the item characteristics of the PDI-21 and the MIS in community adolescents.

2. Method

2.1. Participants

Year 10 students from one girls high school and one boys high school located in Incheon (population density: 2690/km^2, area: 1002 km^2) agreed to participate in the study. Out of 660 written informed consent forms sent out, 310 (47.0%) were returned, resulting in a total of 310 Year 10 students between 15 and 17 years in age, who completed the Korean version of the PDI-21, the MIS, the STA and the SCL-90-R. In the recruiting process, students who had a history of psychiatric illness, a history of psychiatric treatment or family members with a psychiatric history were asked not to participate. This recruitment method was similar to the method used by Peters et al. in the standardization of the original PDI-40 (Peters et al., 1999). We specifically chose the Year 10 students (15–17 year-old age range), because the onset of the first episode of psychosis typically occurs during late adolescence or early adulthood (Yung et al., 2009). All participants agreed to participate in the 6-month follow-up. Accordingly, the students were contacted through their school and asked to complete another PDI-21 after 6 months. A total of 276 adolescents completed and returned the 6-month follow-up questionnaire. This study was conducted in accordance with the latest version of the Declaration of Helsinki. The details of the study design were approved by the Institutional Review Board of SMG-SNU Boramae Medical Center (06-2006-23).

2.2. Measures

2.2.1. The 21-item Peters et al. Delusions Inventory (PDI-21)

The PDI-21 was translated by two board-certified psychiatrists (HYJ and JSY) into Korean, after which it was translated back into English by a native English speaker (SH) and compared with the original PDI-21 items to verify that the meaning of the scale items had not been changed during the translation process. Finally, the translation was confirmed by both Korean- and English-language specialists.

2.2.2. Magical Ideation Scale (MIS)

The MIS is a self-report measure consisting of 24 Yes/No items (Eckblad and Chapman, 1983). The total score on the MIS is obtained by assigning one point to each positive reply (Yes) and zero points to each negative reply (No) and then summing the number of positive answers (maximum score=24). The Korean version of the MIS was standardized and validated with adequate reliability (Cronbach's alpha=0.81, test-retest reliability=0.83) (Choi and Yang, 1997).

2.2.3. Schizotypal Personality Scale (STA)

The Korean version of the STA (Jung et al., 2008; Kim, 2004) is a self-report measure composed of 37 Yes/No items and is designed to examine the various characteristics of general schizotypal traits (Claridge and Broks, 1984).

2.2.4. Symptom Checklist-90-R (SCL-90-R)

The SCL-90-R is a self-report measure of psychiatric symptoms that is widely used in both community and clinical populations (Derogatis, 1977; Kim and Kim, 1984). Consisting of a five-point Likert scale (ranging from 0 to 4), the measure is designed for individuals 13 years of age and older. The SCL-90-R yields 10 separate scores: a total score and subscores for somatization, obsession–compulsion, interpersonal sensitivity, depression, anxiety, hostility, phobic anxiety, paranoid ideation and psychoticism.

2.3. Statistical methods

Statistical analyses were performed using SPSS 13.0 for Windows (SPSS Inc., Chicago, IL). According to the results of the normality test, Student's *t*-tests, analyses of variances (ANOVAs), and Mann–Whitney *U*-tests were used for between-group comparisons. Pearson and Spearman tests were performed to examine correlations between continuous variables, and chi-square tests were used for comparison of categorical variables. Cronbach's (1951) alpha and the item-to-total (Yes/No) score correlation were used to confirm the internal consistency of the scale. Correlations among the PDI-21, MIS, STA, and SCL-90-R were examined to confirm criterion validity, and the test-retest reliability was compared using the intra-class correlation coefficient. A principal component analysis with a varimax rotation was also conducted to investigate the internal structure of the PDI-21.

We performed item response theory (IRT) analysis to quantitatively evaluate and compare the PDI-21 and the MIS in terms of item-level usefulness and measurement precision (Ferrando, 2001). The two-parameter logistic item response model, which consisted of two essential determinants, the level of the delusion proneness (item difficulty) and the differential discrimination among persons (item discrimination), was used based on a previous IRT analysis of the Korean version of the PDI-40 in adults (Jung et al., 2008).

The difficulty parameter in this study represents the level of delusion proneness corresponding to a 50% chance of endorsing the item. The discrimination parameter represents how well the item differentiates the adolescents with a low level of delusion proneness from adolescents with a high level of delusion proneness. According to Baker's (1985) suggestions regarding verbal descriptions of difficulty and discrimination levels, five levels of item difficulty were applied: 'very easy (<-2.0)', 'easy (from -2.0 to -0.5)', 'medium (from -0.5 to $+0.5$)', 'difficult (from $+0.5$ to $+2.0$)' and 'very difficult ($>+2.0$)'. In addition, seven levels of item discrimination were applied in the logistic model: 'none (0)', 'very low (0.01–0.34)', 'low (0.35–0.64)', 'moderate (0.65–1.34)', 'high (1.35–1.69)', 'very high (>1.70)' and 'perfect ($+$ infinity)'. Finally, we derived test information curves for the PDI-21 and the MIS to compare the respective range of maximum information for delusion proneness. The test information curve visually summarizes test information at a specific level of delusion proneness, thus indicating the efficacy of the test (PDI-21 or MIS) in estimating the 'delusion proneness' across the entire range of delusion proneness (Grimm and Yarnold, 2000).

3. Results

3.1. Sample characteristics

The clinical and demographic features of the participants are summarized in Table 1. There were no significant gender differences in the total scores for the PDI-21, MIS, STA, or SCL-90-R. Similarly, there were no significant gender differences in the distress, preoccupation and conviction dimension scores of the PDI-21.

3.2. Convergent validity: inter-correlations among the measures

The total Yes/No score of the PDI-21 showed significant correlation with the total scores of the MIS ($r=0.58$), the STA ($r=0.64$) and the SCL-90-R ($r=0.58$). The PDI dimension scores (distress, preoccupation, conviction) also showed significant correlation with the total scores of the MIS ($r=0.53$–0.58), the STA ($r=0.63$–0.65) and the SCL-90-R ($r=0.58$–0.63, Table 2). All subscale scores of the SCL-90-R also showed significant correlation with the total score of the PDI-21 ($r=0.37$–0.54). The somatisation ($r=0.37$) and phobic ($r=0.43$) subscale demonstrated weakest correlation with PDI-21 total Yes/No scores, whereas the paranoid ideation ($r=0.53$) and psychoticism ($r=0.54$) subscales demonstrated the strongest correlation.

3.3. Reliability: internal consistency

Item to total score correlations ranged from 0.18 to 0.57 for the PDI-21 and the MIS ($p<0.01$, Tables 3 and 4), while the

Table 1
The characteristics of the participants.

	PDI-21 Mean (SD)							MIS	STA	SCL-90-R
	Yes/No	Distress	Distress weighted	Preoccupation	Preoccupation weighted	Conviction	Conviction weighted			
Total	4.89 (3.78)	11.37 (10.62)	2.19 (0.83)	13.08 (12.24)	2.50 (0.82)	14.02 (12.68)	2.75 (0.83)	4.82 (3.73)	7.27 (5.88)	48.05 (41.97)
Male	4.62 (3.80)	10.46 (10.09)	2.15 (0.89)	12.47 (12.48)	2.51 (0.86)	13.81 (13.55)	2.51 (0.86)	4.49 (3.36)	6.77 (5.76)	46.47 (43.87)
Female	5.17 (3.75)	12.36 (11.12)	2.24 (0.78)	13.75 (11.99)	2.49 (0.75)	14.26 (11.70)	2.49 (0.77)	5.18 (4.07)	7.82 (5.99)	49.77 (39.89)
Range	0–18	0–55		0–84		0–85			0–31	1–236
Median	4	8		9.5		10		4	6	35
Mode	0	0		0		0		4	0	8

PDI, Peters et al. Delusions Inventory; Distress, PDI Distress Dimension Score; Preoccupation, PDI Preoccupation Dimension Score; Conviction, PDI Conviction Dimension Score.
MIS, Magical Ideation Scale; STA, Schizotypal Personality Scale; SCL-90-R, Symptom Check List-90-R.
Weighted scores were calculated by dividing each dimension score of the PDI-21 by the total PDI Yes/No score.

Table 2
The correlations between the PDI-21, Schizotypal Personality Scale, Magical Ideation Scale and SCL-90-R.

r^*	MIS	STA	SCL-90-R ($N=310$)									
			Total	SOM	O–C	I-S	DEP	ANX	HOS	PHO	PARA	PSY
PDI-21 Yes/No	0.58	0.64	0.58	0.37	0.49	0.52	0.47	0.52	0.48	0.43	0.53	0.54
Distress	0.53	0.63	0.62	0.40	0.51	0.55	0.53	0.54	0.52	0.44	0.57	0.57
Preoccupation	0.57	0.65	0.63	0.40	0.53	0.55	0.50	0.55	0.52	0.44	0.58	0.57
Conviction	0.57	0.65	0.61	0.38	0.52	0.53	0.49	0.53	0.49	0.41	0.56	0.56

PDI, Peters et al. Delusions Inventory; Distress, PDI Distress Subscale score; Preoccupation, PDI Preoccupation Subscale score; Conviction, PDI Conviction Subscale score.
MIS, Magical Ideation Scale; STA, Schizotypal Personality Scale; SCL-90-R, Symptom Checklist-90 Revised.
SOM, Somatisation; O–C, Obsession–compulsion; I-S, Interpersonal sensitivity; DEP, Depression; ANX, Anxiety; HOS, Hostility; PHO, Phobic anxiety; PARA, Paranoid ideation; PSY, Psychoticism.
*All of the statistics were significant at $p<0.001$.

Table 3
The correlations of the item-to-total (Yes/No) score (rit) and the rank of endorsement among items on the PDI-21.

PDI-21 Items	Rank	Endorsed (%)	Rit
Have no thought in head	1	42.3	0.43
Thought influenced by devices	2	41.6	0.44
Receive odd looks from people	3	33.9	0.50
Telepathic communication	4	33.2	0.47
Sinned more than average	5	31.9	0.48
People are not who they seem	6	30.3	0.49
Being very important	7	29.0	0.47
Being special or unusual	8	24.2	0.51
End of the world	9	23.5	0.47
Thought broadcasting	9	23.5	0.48
Contents directed at me in media	9	23.2	0.45
Double meanings	12	22.9	0.43
Alien thoughts	13	22.3	0.54
Witchcraft, voodoo	13	22.6	0.35
Being persecuted	15	20.0	0.35
Thought echoes	16	15.8	0.38
Chosen by God	17	14.2	0.39
Feel like robot or zombie	18	12.6	0.41
Being close to God	19	9.7	0.27
Conspiracy	20	8.7	0.35
Unfaithfulness of a partner	21	3.2	0.18

PDI, Peters et al. Delusions Inventory; Rank, rank of endorsements among 21 items of the PDI-21.

Cronbach's alpha was 0.79 for the PDI-21, 0.79 for the MIS and 0.87 for the STA, indicating a high degree of internal consistency for all three measures (Nunnally and Beristein, 1994).

The intra-class correlation for the test-retest reliability, based on the data obtained from the 276 adolescents (89%) who also participated in the 6-month follow-up, was 0.52 (95% CI=0.43–0.60, $p<0.01$) for the PDI-21 total Yes/No score; 0.48 (0.38–0.56, $p<0.01$) for the distress dimension; 0.55 (0.46–0.62, $p<0.01$) for the preoccupation dimension; and 0.57 (0.49–0.65, $p<0.01$) for the conviction dimension. There was no significant difference in the demographic and clinical features between those who returned the follow-up package and those who did not, except that those who responded ($N=276$, MIS=4.65 ± 3.65, psychoticism=3.13 ± 5.21) scored lower on the baseline total score of the MIS ($Z=-2.05$, $p=0.04$) and the psychoticism subscale ($Z=-2.30$, $p=0.02$) of the SCL-90-R than did their non-responding counterparts ($N=34$, MIS=6.24 ± 4.12, psychoticism=4.18 ± 4.81).

3.4. Endorsement rate of items

With respect to the PDI-21, 15 items showed an endorsement rate above 20%, while for the MIS, 10 out of the 24 items showed an endorsement rate above 20%. The most commonly endorsed items on the PDI-21 were related to bizarre experience and paranoid ideation [e.g.,'have no thoughts in head' (42.3%); 'thoughts influenced by devices' (41.3%); 'receive odd looks from people' (33.9%) and 'telepathic communication' (33.2%)] (Table 3). In comparison, the most commonly endorsed items on the MIS were items regarding mystical and magical ideation [e.g., 'my thoughts belong to others' (51.9%); 'good luck charms' (45.8%); 'dead influence the living' (44.5%); 'cause something by thinking' (38.4%) and 'powers of numbers like 13 and 7′ (36.8%)] (Table 4).

3.5. Dimensionalities of the scales

In the principal component analysis, the unidimensionality of the PDI-21 and the MIS was supported by the first eigenvalue, which was substantially larger than the eigenvalues of subsequent factors (eigenvalue for the first factor of the PDI=4.16, 19.8% variance explained; MIS=4.66, 19.4%). The high eigenvalue ratio of the first factor with respect to the other factors and the Scree plot supported the parsimonious single-factor model. The results showed that the items on the PDI-21 and MIS collectively represent a single latent dimension, thereby fulfilling the requirement for IRT analysis.

Table 4
The correlations of the item-to-total score (rit) and the rank of endorsement among items on the MIS.

MIS Items	Rank	Endorsed (%)	Rit
My thoughts belong to others	1	51.9	0.18
Good luck charms	2	45.8	0.30
Dead influence the living	3	44.5	0.57
Cause something by thinking	4	38.4	0.51
Powers of special numbers	5	36.8	0.38
Little rituals against negative influences	6	34.2	0.53
Government conceals flying saucers	7	27.7	0.48
Evil presence	8	23.5	0.48
Learn mind reading	9	23.2	0.50
Unusual experience and reincarnation	10	22.6	0.46
Mind read by strangers	11	17.7	0.50
People on other planets influence Earth	12	14.8	0.51
Hand motions of strangers influence me	12	13.2	0.53
Replaced by look-alikes	14	11.6	0.40
Broadcasters know I am listening	15	9.7	0.41
Something new in record sounds	16	9.4	0.41
Lectures are meant for me	17	8.7	0.38
Things seem displaced	18	8.4	0.39
Horoscopes are right too often	19	8.1	0.38
Feeling of gaining or losing energy	20	7.7	0.39
People are part of an experiment	21	7.1	0.39
Fear of stepping on cracks	22	6.1	0.31
Arrangements of things have messages	22	6.1	0.41
Feelings of not being human	24	4.8	0.37

MIS: Magical Ideation Scale; Rank: rank of enforcement among 24 items of the MIS.

3.6. Item response theory analysis

The item characteristics of the PDI-21 and the MIS were compared (Table 5). According to Baker's (1985) classification of item discrimination, our results indicate that, for the PDI-21, seven items demonstrated very low (0.01–0.34) discrimination, 13 items demonstrated moderate to high (0.65–1.69) discrimination, and one item demonstrated very high (>1.7) discrimination. According to the five classifications of item difficulty (more difficult items represent more delusion items) also suggested by Baker (1985), four items on the PDI-21 were very easy (<-2.0), 10 were easy (from -2.0 to -0.5) and seven were very difficult ($>+2.0$). For the MIS measure, 14 items demonstrated very low to low discrimination (0.01–0.64) and 10 demonstrated moderate to high (0.65–1.69) discrimination, while 11 items were very easy (<-2.0), 11 were medium to difficult (from -0.5 to $+2.0$) and two were very difficult ($>+2.0$).

To evaluate the item-level usefulness of the PDI-21 and the MIS in assessing delusion proneness in community adolescents, the test information function was applied (Fig. 1). The scale information curve of the PDI-21 items provided the maximum amount of information at -1.4 (easy) level of delusion proneness, whereas the MIS showed the maximum information at $+1.2$ (difficult), which suggested that the MIS items produced maximum information at higher levels of delusion proneness when compared with the PDI-21.

4. Discussion

In this study, we found that the Korean version of the PDI-21 exhibited good internal consistency and excellent correlation with other self-reported rating scales measuring delusion proneness in community adolescents. Moreover, the validity of the PDI-21 in adolescents was comparable to the validity of the PDI-40 in adults. Cronbach's alpha coefficient was 0.92 for the PDI-40 in adults (Jung

Table 5
The discrimination powers and difficulty (delusion proneness) of each item on the PDI-21 and MIS.

PDI-21 Item	Discrimination (S.E)	Difficulty (S.E.)	MIS Item	Discrimination (S.E.)	Difficulty (S.E.)
Thought broadcasting	1.73 (0.38)	−1.08 (0.14)	Dead influence the living	1.51 (0.31)	0.20 (0.10)
Have no thought in head	1.24 (0.24)	−0.70 (0.14)	Learn mind reading	1.40 (0.32)	1.14 (0.19)
Being close to God	1.18 (0.24)	−1.23 (0.21)	Hand motions of strangers influence me	1.35 (0.31)	1.82 (0.30)
Double meanings	1.17 (0.31)	−2.04 (0.37)	Evil presence	1.15 (0.26)	1.27 (0.23)
Telepathic communication	1.16 (0.31)	−2.31 (0.44)	Mind read by strangers	1.15 (0.27)	1.66 (0.30)
Witchcraft, voodoo	1.12 (0.27)	−1.96 (0.35)	Arrangements of things have messages	1.13 (0.34)	2.89 (0.62)
Feel like robot or zombie	1.09 (0.26)	−1.87 (0.34)	Fear of stepping on cracks	1.12 (0.45)	2.90 (0.77)
Receive odd looks from people	1.07 (0.22)	−0.87 (0.16)	Little rituals against negative influences	1.10 (0.24)	0.74 (0.17)
Alien thoughts	1.06 (0.22)	−1.35 (0.24)	Unusual experience and reincarnation	1.09 (0.24)	1.39 (0.26)
People are not who they seem	1.04 (0.22)	−1.40 (0.24)	Cause something by thinking	1.07 (0.23)	0.54 (0.15)
Being very important	1.04 (0.31)	−2.66 (0.59)			
Conspiracy	0.89 (0.21)	−1.80 (0.35)	Powers of special numbers	0.43 (0.13)	1.32 (0.47)
Sinned more than average	0.73 (0.27)	−4.98 (1.64)	Good luck charms	0.35 (0.11)	0.50 (0.37)
Chosen by God	0.65 (0.15)	−0.60 (0.22)	My thoughts belong to others	0.24 (0.08)	0.34 (0.50)
			People are part of an experiment	0.18 (0.06)	−14.49 (5.53)
Unfaithfulness of a partner	0.20 (0.06)	6.32 (2.20)	Feelings of not being human	0.18 (0.07)	−16.45 (6.56)
Thought influenced by devices	0.15 (0.05)	4.72 (1.71)	Things seem displaced	0.18 (0.06)	−13.73 (5.21)
Contents directed at me in media	0.14 (0.04)	8.72 (2.98)	Feelings of gaining or losing energy	0.17 (0.06)	−15.06 (5.73)
Being persecuted	0.14 (0.04)	6.19 (2.17)	Lectures are meant for me	0.17 (0.06)	−13.96 (5.33)
Being special or unusual	0.12 (0.04)	7.24 (2.51)	Something new in record sounds	0.16(0.05)	−14.71 (5.48)
End of the world	0.14 (0.04)	2.31 (1.11)	Horoscopes are right too often	0.16 (0.06)	−15.21 (5.77)
Thought echoes	0.12 (0.04)	9.65 (3.26)	Replaced by look-alikes	0.15 (0.05)	−13.21 (4.89)
			Broadcasters know I am listening	0.15 (0.05)	−14.82 (5.51)
			People on other planets influence Earth	0.13 (0.04)	−13.69 (4.90)
			Government conceals flying saucers	0.12 (0.04)	−8.31 (2.97)

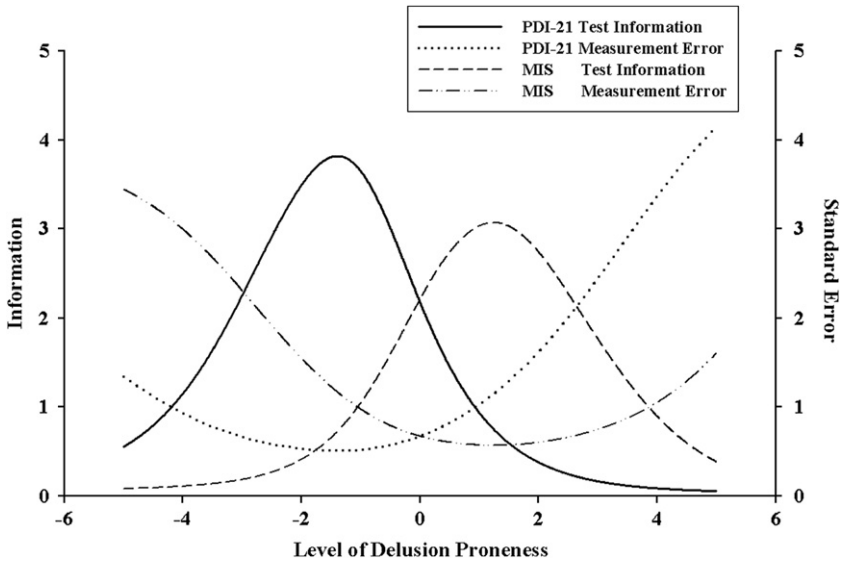

Fig. 1. Test information and measurement error for the PDI-21 and the MIS. The test information curve visually summarizes test information at a specific level of delusion proneness, thus indicating the efficacy of the test (PDI-21 or MIS) in estimating the 'delusion proneness' across the entire range of delusion proneness. The measurement error shows the reciprocity of the standard error with the test information function. A decrease in the standard error of the estimated delusion proneness reflects an increase in the quantity of information.

et al., 2008), whereas it was 0.79 for the PDI-21 in adolescents. These results showed that the PDI-21 can be used with community adolescents as both an informative and a reliable self-report measure for the assessment of delusion proneness.

We also conducted a 6-month follow-up of the PDI-21 assessment with a high return rate (89%) and found significant correlations (r=0.52) between the initial assessment scores and the 6-month follow-up scores for the distress, preoccupation and conviction dimensions of the PDI-21. The test-retest reliability was lower than that measured by Peters et al. (1999) with 83 adults (r=0.82). There is the possibility that the changing nature of the belief system in a developing adolescent may have resulted in genuine item endorsement changes. Moreover, it should be noted that the adolescent brain is undergoing neurodevelopmental processes of maturation, which may play a role in the phenotypic expression of schizotypal traits (Walker and Bollini, 2002).

We used IRT analysis in a real community sample to assess the psychometric properties of the PDI-21 and the MIS. We found that the PDI-21 yields more information at lower levels of delusion proneness, while the MIS yields more information at higher levels of delusion proneness. These results suggest that combining the PDI-21 and the MIS may be effective in evaluating a broad range of delusion proneness among community adolescents. These findings lend support to previous suggestions that combinations of the PDI-21 with other instruments that assess sub-clinical delusion proneness may be necessary (Jones and Fernyhough, 2007).

Previous reports have suggested that psychotic-like experiences may be divided into four categories in community adolescents: bizarre experiences, paranoid ideation, magical thinking and perceptual abnormality (Yung et al., 2009). Upon a closer examination of the individual items of the PDI-21 and the MIS using these categories, the most commonly endorsed items on the PDI-21 were items about paranoid ideation and bizarre experiences. This finding is consistent with previous studies that have reported significant endorsement of paranoid ideation in adolescents when using the PDI measure (Cella et al., 2011).

In comparison, the most commonly endorsed items on the MIS were related to mystical or magical thinking, which reflects the developmental goal of the MIS, i.e. to examine beliefs that may be regarded as first-rank symptoms along with beliefs that may be considered ordinary superstitions, such as lucky numbers and horoscopes (Eckblad and Chapman, 1983). Adolescence is a period in which belief systems go through a rapid developmental transition from that of a child to an adult (Harrop and Trower, 2003). Therefore, the belief systems of an adolescent may still retain magical and superstitious ideas originating from childhood, which may account for the high frequency of endorsement on magical thinking items as observed on the MIS.

The total Yes/No, distress, preoccupation, and conviction dimension scores of the PDI-21 showed significant correlation with the total scores on the MIS, STA and SCL-90-R. This finding is consistent with previous studies that showed adequate concurrent validity of the PDI with the STA and MIS (Peters et al., 1999). We also found that all subscale scores for the SCL-90-R were correlated consistently with the total Yes/No, distress, conviction and preoccupation dimension scores of the PDI-21. Although the nine symptom dimensions of the SCL-90-R do not correspond directly with a diagnosis based on either the DSM-IV or the ICD-10 nomenclature (Cyr et al., 1985), studies that have analyzed the construct of the SCL-90-R have indicated that the scale is composed of a single predominant factor reflecting 'general psychological distress' (Prunas et al., 2011; Rauter et al., 1996). The positive association between the PDI and the SCL-90-R in the present study suggests that adolescents with elevated PDI-21 scores may also experience elevated psychological distress, which is consistent with previous studies that showed sub-threshold psychotic-like symptoms may be associated with distress and depression among non-psychiatric community individuals (Armando et al., 2010; Compton et al., 2008; Nishida et al., 2008; Preti et al., 2007).

There are several issues that should be considered when interpreting the results of this study. It should be noted that there may be some overlap in the items of the MIS and PDI-21 because both scales were developed based on Meehl's quasi-dimensional view of 'schizotypy' (Eckblad and Chapman, 1983; Peters et al., 1999). Furthermore, although the term 'delusion proneness' was used to refer to the phenomena explored by the PDI-21 and the MIS due to the lack of a better term, it is not a term that can be used to accurately describe a priori non-pathological phenomena (Verdoux et al., 1998). The sample

population also must be taken into consideration when interpreting the risk for delusion proneness in adolescents. In this study, only non-clinical participants were included and the response rate was relatively low (47%); therefore, caution should be used in generalizing our findings. Although students who had history of psychiatric illness, a history of psychiatric treatment, or family members with a psychiatric history were asked not to participate, we cannot rule out the possibility that students with psychiatric disorders were included in the sample. Therefore, future studies may wish to consider screening for psychiatric history using direct interviews to further exclude such a possibility.

The results of our study suggest that the PDI-21 can be applied as both an informative and a reliable self-report measure for detection and assessment of delusion proneness in community adolescents. We also found through IRT analysis that the PDI-21 provides more information at the lower range and the MIS at the higher range of delusion proneness. These two measures should therefore be used complementarily to cover a broad range of delusion proneness in community adolescents.

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