Reliability of factorial structure of the Peters et al. delusions inventory (PDI-21)

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Abstract

The 21-item version of the Peters et al. Delusions Inventory (PDI-21) is a commonly used tool to measure delusional ideation in the normal population. Two recent principal component analyses have concluded that the PDI-21 has a seven-factor structure. Although these studies found identical factors associated with religiosity and grandiosity, the items loading on the remaining five factors, and hence the interpretation of these, differed. Such seven-factor structures of the PDI-21 are beginning to be used in research; however, a consistent item-level seven-factor structure has not been replicated and no data have been reported to support the reliability of such factors. We administered the PDI-21 to a non-psychiatric sample (N = 493). It was found that, with the exception of religiosity/religiousness, the previously reported factors of the PDI-21 had Cronbach’s alphas of less than 0.7. After a factor analysis using principal axis factoring, parallel analysis suggested the extraction of three factors. Of these factors, only one (religiosity/religiousness) was found to be both internally reliable and meaningful. It is concluded that the PDI-21 is best used with a unidimensional scoring system and that new measures are needed to assess specific types of delusion-like beliefs in the normal population.

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1. Introduction

Delusional beliefs have been found not to be limited to pathological conditions but also to exist in the normal population (Eaton, Romanoski, Anthony, & Nestadt, 1991; Johns & van Os, 2001). However, measurement of such sub-clinical delusional beliefs has until recently been problematic. Peters, Joseph, and Garety (1999) noted that existing psychometric instruments either examined first-rank symptoms of psychosis, which are rarely endorsed by the general populace, or asked about superstitious beliefs which are widespread and thus, hard to justify as delusional. Furthermore, the existing measures only investigated a subset of the delusional themes found in psychosis. In order to address these problems the Peters et al. Delusions Inventory was developed (Peters et al., 1999). This is a 40-item measure of tendency to delusional ideation in non-clinical samples. In order to make this tool easier to administer, an abbreviated 21-item version was subsequently developed.

The 21-item Peters et al. Delusions Inventory (PDI-21; Peters & Garety, 1996; Peters, Joseph, Day, & Garety, 2004) was designed to measure delusional ideation in the general population incorporating measures of the distress, preoccupation and conviction associated with delusional beliefs. Its originators specifically designed the PDI-21 not to consist of a limited number of well-defined subscales with high internal reliability but instead to “sample as wide a variety of delusions as possible” (Peters et al., 2004, p. 558). Accordingly, the inventory contains items addressing a wide range of delusional beliefs. The authors note that paranoia is a central theme of the PDI-21, with multiple items measuring persecution, suspiciousness and paranoid ideation. Amongst other delusional beliefs addressed are those relating to religiosity, grandeur, reference and depersonalisation. Peters et al. (2004) performed a confirmatory factor analysis ($N = 444$) with a forced one-component solution of the PDI-21. Loadings on this single factor ranged from 0.31–0.63, which was taken to support the adequacy of a unidimensional scoring system for the PDI-21. Given this intended unidimensional scoring system, a principal components analysis (PCA) was not performed to investigate multifactoriality.

In a separate study, Verdoux et al. (1998) administered a French translation of the PDI-21 to a sample of adults ($N = 444$) with no history of psychiatric disorder. A PCA using varimax rotation was performed on the PDI-21 items. A total of seven factors with eigenvalues greater than one (which explained 55.3% of the variance) were found and hence, following Kaiser’s (1960) eigenvalue rule, seven factors were extracted. These factors were labeled as persecution, thought disturbances, grandiosity, religiosity, paranormal beliefs, reference guilt, and apocalypse. Verdoux et al. then went on to examine the association between each of these factors and participants’ age and gender. Associations were reported between five of the seven factors of the PDI-21 (persecution, thought disturbances, grandiosity, religiosity and paranormal beliefs) and age, as well as an association between one factor (religiosity) and gender.

One limitation of this study was that it used Kaiser’s rule to select the number of factors extracted. Tabachnick and Fidell (2007) note that Kaiser’s rule should function as a “quick first estimate” (p. 644) of the number of factors, and that this procedure may lead to incorrect estimation of the number of factors to be extracted. A second limitation was the failure to report whether the factors had adequate internal reliability. Internal reliability can be assessed through an examination of a factor’s Cronbach’s alpha values (e.g., Blumberg, 2000), and is generally accepted to be guaranteed by a Cronbach’s alpha greater than 0.7 (Bland & Altman, 1997). The failure of Ver-
doux et al.’s study to report such data raises questions over the reliability, and hence validity, of the reported associations between these factors and participants’ age and gender.

The only other study to have examined the factor structure of the PDI-21 is that of Lopez-Ilundain, Perez-Nievas, and Otero (2006). A Spanish translation of the PDI-21 was administered to a general population sample (N = 356), and showed good overall internal reliability (Cronbach’s alpha = 0.75). Lopez-Ilundain et al. performed a PCA with varimax rotation on the data and, using Kaiser’s rule, a total of seven factors which accounted for 53.7% of the variance were identified. Both the number of factors and the percentage of the variance explained were hence consistent with the PCA of Verdoux et al. (1998). These factors were interpreted by Lopez-Ilundain et al. as experiences of influence, depressive, paranoid, grandiosity, referential, magic thinking, and religiousness. Associations were reported between five of the seven factors of the PDI-21 (experiences of influence, depressive, paranoid, grandiosity, referential, magic thinking, and religiousness) and age, as well as an association between one factor (magic thinking) and gender. However, this study shares the limitations of Verdoux et al. (1998), namely the use of Kaiser’s rule to determine factor structure and the failure to report internal reliability data for these factors.

A comparison of the factors identified by Verdoux et al. (1998) and Lopez-Ilundain et al. (2006) and the PDI-21 items loading onto each of them is shown in Table 1. Both studies identified religiosity/religiousness and grandiosity as factors of the PDI-21, with the same items loading onto each factor in each study. Two other factors are similar between the two studies (persecution/paranoid and paranormal beliefs/magic thinking) albeit with some variance in items loading onto these factors. However, the remaining factors do not agree well with each other.

The seven factors of the PDI-21 found by Verdoux et al. (1998) were subsequently incorporated into a study by Laroi and Van der Linden (2005). This study examined the relations between student participants’ scores on Verdoux et al.’s seven factors and their metacognitive beliefs (beliefs about thought processes). A range of associations between these variables were reported. However, the significance of these findings are limited by the failure to report internal reliability statistics on Verdoux et al.’s factors.

Given that multidimensional treatments of the PDI-21 are beginning to appear in the literature, a reexamination of the factor structure of the PDI-21 and a reliability analysis of the factors found by Verdoux et al. (1998) and Lopez-Ilundain et al. (2006) would appear to be a timely exercise. We

| Table 1 |
| Factors and their constituent items found by two studies of the PDI-21’s factor structure |
| Persecution | 1, 3, 4, 5 | Paranoid | 4, 5 |
| Thought disturbances | 13, 16, 19, 20, 21 | Experiences of influence | 10, 18, 19 |
| Grandiosity | 6, 7 | Grandiosity | 6, 7 |
| Religiousness | 8, 11 | Religiousness | 8, 11 |
| Paranormal beliefs | 9, 12 | Magic thinking | 3, 9, 12, 17 |
| Reference built | 2, 10, 14 | Referential | 1, 15, 16 |
| Apocalypse | 17, 18 | Depressive | 13, 14, 20, 21 |

Note. Item 15 was not found to load onto any factor by Verdoux et al. Item 2 did not clearly load onto any one factor in Lopez-Ilundain et al.’s study.
set out to administer the PDI-21 to a non-psychiatric population to address the following questions:

(1) Are the factors found by Verdoux et al. and Lopez-Ilundain et al. internally reliable (i.e., have Cronbach’s alpha greater than 0.7)?
(2) Can the factor structure of the PDI-21 found by Verdoux et al. or Lopez-Ilundain et al. be replicated?
(3) If a different factor structure is found to those reported by Verdoux et al. and Lopez-Ilundain et al., then are the resulting factors internally reliable?

It was hypothesized, following Peters et al.’s (2004) intention for the PDI-21 to have a unidimensional scoring system, that any factor structure emerging from the analysis would not result in internally reliable factors.

2. Method

2.1. Participants

A circular e-mail was sent to undergraduates informing them of a website where they could take part in the study. A total of 493 undergraduates (175 males and 318 females) from a variety of departments at a British university took part in the study. The mean age of participants was 19.1 years (SD = 2.5). No incentive was offered for participants to take part in the study, and the questionnaire was completed anonymously.

2.2. Measures

Participants were asked to complete the Peters et al. Delusions Inventory (PDI-21; Peters et al., 2004). This has been shown to possess internal reliability (with a unidimensional scoring system) and test–retest reliability as well as construct and criterion validity (Peters et al., 2004). For each question (e.g., ‘Do you ever feel people are reading your mind?’) participants answer ‘yes’ (scored as 1) or ‘no’ (scored as 0). If ‘yes’ is selected, participants are asked to rate the distress, preoccupation and conviction with which the belief is associated on a five-point Likert scale (1–5). These scores are then summed leading to scores on each item ranging from 0–16. Total scores on the inventory may hence range from 0–336. The wording of the PDI makes clear that it is not intended to include experiences resulting from drug use.

3. Results

The mean PDI-21 total score was 49.24 (SD = 32.9). This is slightly lower than the mean of 58.9 (SD = 48.0) of the PDI-21 reported by Peters et al. (2004) and is probably due to the greater homogeneity of the student sample used here, as compared to the adult sample used by Peters et al. (2004). The mean male score of 48.94 (SD = 33.55) was compared to that for females of
49.40 (SD = 32.65) and found not to be significantly different, \( t(491) = 0.15 \), n.s. This is in line with the finding of Peters et al. (2004). Correlations between scores on the three response scales (distress, preoccupation and conviction) ranged from \( r = 0.87, p < 0.001 \) to \( r = 0.93, p < 0.001 \).

Cronbach’s alpha for the PDI-21 as a whole was 0.77, suggesting satisfactory internal reliability. Cronbach’s alphas, per the data from this study, for the factors identified by Verdoux et al. (1998) and Lopez-Ilundain et al. (2006) are presented in Table 2. Only one factor in each structure, that relating to religiosity, was found to have a Cronbach’s alpha greater than 0.7.

A factor analysis was performed on the present data using principal axis factoring, in an attempt to detect structure in the PDI-21. The Kaiser–Meyer–Olkin measure of sampling adequacy was 0.76 and the Bartlett test of sphericity statistic was 1717, \( p < 0.001 \), indicating that the assumptions for a factor analysis were met. Principal axis factoring yielded a total of seven factors with eigenvalues greater than 1, which accounted for 55.1% of the variance. This is consistent with the exploratory principal components analyses performed on the PDI-21 by Verdoux et al. (1998) and Lopez-Ilundain et al. (2006), which both found seven eigenvalues over 1 to account for 53–55% of the variance. Kaiser’s guideline of retaining all factors with eigenvalues of greater than 1 would hence suggest that seven factors should be extracted. However, Kaiser’s guideline has a number of limitations, among them its tendency to overestimate the number of factors that should be extracted and its arbitrary nature (Hayton, Allen, & Scarpello, 2004). An alternative criterion for the numbers of factors to extract is the scree test (Cattell, 1966) which involves the examination of the scree plot for discontinuities. An examination of the scree plot (Fig. 1) showed no clear discontinuity in the slope after seven factors, suggesting that extracting this number of factors is not appropriate (Tabachnick & Fidell, 2007). However, one point of discontinuity is seen after one factor. This is in line with the intended unidimensional nature of the PDI-21, and its overall Cronbach’s alpha of 0.77. The scree plot can also be interpreted as having discontinuities after either three or five factors. Horn (1965) proposed using parallel analysis to address the problem of subjectivity in interpreting scree plots. Accordingly, a parallel analysis was performed on the present data set using the procedure recommended by Hayton et al. (2004). Firstly, a random data set was generated based on the sample size (\( N = 493 \)) and the number of variables involved in the study (\( N = 21 \)). Secondly, a principal components analysis was performed on the randomly generated data, and the eigenvalues generated were recorded. This was repeated 50 times. The resultant mean and 95th percentile of each eigenvalue are presented in Table 3. Only the first three

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<tr>
<td>Persecution</td>
<td>0.50</td>
<td>Paranoid</td>
<td>0.26</td>
</tr>
<tr>
<td>Thought disturbances</td>
<td>0.32</td>
<td>Experiences of influence</td>
<td>0.33</td>
</tr>
<tr>
<td>Grandiosity</td>
<td>0.68</td>
<td>Grandiosity</td>
<td>0.68</td>
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<tr>
<td>Religiosity</td>
<td>0.80</td>
<td>Religiousness</td>
<td>0.80</td>
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<tr>
<td>Paranormal beliefs</td>
<td>0.51</td>
<td>Magic thinking</td>
<td>0.49</td>
</tr>
<tr>
<td>Reference guilt</td>
<td>0.23</td>
<td>Referential</td>
<td>0.38</td>
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<tr>
<td>Apocalypse</td>
<td>0.47</td>
<td>Depressive</td>
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actual eigenvalues were greater than the randomly generated eigenvalues, suggesting that three factors should be extracted. The same conclusion was reached when mean random eigenvalues were calculated using a Monte Carlo principal components analysis program with 1000 repetitions.

The principal axis factoring for this three-factor structure was performed with oblique rotation, as work by Freeman, Garety, Kuipers, Fowler, and Bebbington (2002) has suggested that some types of delusions (specifically persecutory delusions and delusions of reference) may correlate with each other. Two of the three correlations between the three factors after oblique rotation were greater than 0.30, suggesting that oblique rotation was appropriate (Tabachnick & Fidell, 2007).

The three-factor structure is reported in Table 4. Factor 1 had a satisfactory Cronbach’s alpha of 0.69, although its meaning was hard to interpret, appearing to relate to a range of delusional beliefs including grandeur, paranormal beliefs and thought disturbances. This factor incorporated the Grandiosity factor found by Verdoux et al. and Lopez-Illundain, as well as containing a num-

![Fig. 1. Scree-plot for factor analysis.](image-url)
number of other items that load onto other of their factors. Factor 2 had a more satisfactory Cronbach’s alpha of 0.80. This factor corresponds in its item-loading to Verdoux et al.’s Religiosity and Lopez-Ilundain et al.’s Religiousness factor. However, as this factor consists of only two items of the PDI-21, its construct validity is questionable. Factor 3’s Cronbach’s alpha was low at 0.55 and appears to relate to delusions of reference as well as guilt and suspicion. This factor does not correspond to any of those identified by Verdoux et al. and Lopez-Ilundain et al. Deletion of items from the three factors identified (using the ‘if item deleted’ function in SPSS 14) did not serve to increase their Cronbach’s alphas.

For completeness, further factor extractions were also performed based on the Kaiser criterion for factor extraction (which suggested extracting seven factors), and on an arguable discontinuity in the scree plot after five factors. When seven factors were extracted, all items loaded >0.3 onto a factor; however, the interpretation of these factors was not straightforward. One factor incorporated elements of the persecution and thought disturbances factors found by Verdoux et al. and the referential and other factors found by Lopez-Ilundain et al. A second factor appeared to relate to the grandiosity factor identified by Verdoux et al. and Lopez-Ilundain et al. A third factor corresponded in its item-loading to Verdoux et al.’s religiosity and Lopez-Ilundain et al.’s religiousness factor and was the sole factor with a Cronbach’s alpha greater than 0.7. A fourth factor appeared similar to Verdoux et al.’s paranormal beliefs factor, and to the magic thinking factor of Lopez-Ilundain et al. The remaining factors had no easily interpretable meaning and did not equate with any factors found by Verdoux et al. or Lopez-Ilundain et al.

When five factors were extracted, one factor appeared to relate to thought disturbances and incorporated elements of thought disturbances factors found by Verdoux et al. and Lopez-Ilundain et al.
4. Discussion

This study first set out to examine whether the factors of the PDI-21 identified by Verdoux et al. (1998) and Lopez-Iñondain et al. (2006) had satisfactory internal reliability. It was found that, of the seven factors identified by Verdoux et al. and Lopez-Iñondain et al., only religiosity/religiousness had satisfactory internal reliability. The second aim of this study was to see if the factor structures found by Verdoux et al. and Lopez-Iñondain et al. could be replicated. Our factor analysis identified seven eigenvalues greater than one, the same number as Verdoux et al. and Lopez-Iñondain et al. Inspection of the scree plot pointed to a number of possible factor structures being appropriate. This included a possible one-factor solution, in line with the original design of the scale by Peters et al. (2004). A parallel analysis of the present data set suggested the extraction of three factors, two of which were reliable (with a Cronbach’s alpha near or greater than 0.7). One factor was associated with religiosity (corresponding to religiosity/religiousness in the earlier studies), while the other factor was hard to interpret, appearing to relate to a range of delusional beliefs. This suggested that the only specific type of delusion for which derivation of a PDI-21 sub-scale is appropriate is religiosity/religiousness.

When further factor analyses were performed with either five or seven factors the only reliable factor to emerge was religiosity/religiousness. It hence seems plausible that the reason why Verdoux et al., Lopez-Iñondain et al. and the present study found a variety of factor structures and different items loading onto such factors is due to the absence of a valid multifactorial structure of this instrument.

A number of caveats need to be made about these findings. Firstly, this study used the English version of the PDI-21, as opposed to the French version of the PDI-21 used by Verdoux et al. (1998) and Lopez-Iñondain et al. (2006). Secondly, it is possible that our use of on-line questionnaires may have led to a biased pattern of responses. However, we note that Freeman, Dunn, and Garety (2005) have demonstrated this to be a reliable method for gathering data. Thirdly, our sample consisted solely of young students, rather than the range of ages used by both Verdoux et al. and Lopez-Iñondain et al. Finally, we note that Verdoux et al.’s study excluded participants with a history of psychiatric disorder (as reported by general practitioners). In contrast, neither our participants, nor those of Peters et al. (2004) and Lopez-Iñondain et al., were screened for a history of psychiatric disorder. Although it seems unlikely that the inclusion of participants with a history of mental illness could explain the discrepancy in factor structures in the PDI-21, future studies may wish to consider screening for psychiatric history. We would also note, however, that our sample consisted of young university students, for whom a history of psychiatric disorders with delusional components would be unlikely. Furthermore, it is worth noting
that our report has not touched on the sensitivity of incidence of delusions to cultural changes in a society (Levinson, 1973), and indeed the labeling of such experiences as delusional is also culturally determined (Georgaca, 2004).

We conclude that the use of factors of the PDI-21 is not appropriate. As intended by its creators, the PDI-21 appears best employed with a unidimensional scoring system. Our findings suggest that there remains a need for either the creation of new instruments for assessing varieties of sub-clinical delusional ideation in healthy individuals, such as delusions of reference, or the use of existing scales specifically designed to address certain types of sub-clinical delusions in such healthy individuals. For example, it has been suggested that sub-clinical persecutory delusions may be assessed in the healthy population by use of the persecutory ideation questionnaire (McKay, Langdon, & Coltheart, 2006). Relying on dedicated measures of specific delusional thought patterns, rather than the PDI-21, would seem to be a good strategy for future research.

References


