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ORIGINAL ARTICLE

A taxometric analysis of health anxiety

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Background. A long-standing issue in the health anxiety literature is the extent to which health anxiety is a dimensional or a categorical construct. This study explores this question directly using taxometric procedures.

Method. Seven hundred and eleven working adults completed an index of health anxiety [the Whiteley Index (WI)] and indicated their current health status. Data from those who were currently healthy ($n=501$) and receiving no medical treatment were examined using three taxometric procedures: mean above minus below a cut (MAMBAC), maximum eigenvalue (MAXEIGEN) and L-mode factor analysis (L-MODE).

Results. Graphical representations (comparing actual to simulated data) and fit indices indicate that health anxiety is more accurately represented as a dimensional rather than a categorical construct.

Conclusions. Health anxiety is better represented as a dimensional construct. Implications for theory development and clinical practice are examined.

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Introduction

Should health anxiety be conceptualized as a dimensional (continuous) or a categorical (taxonic) construct? Although this question has been debated, to date no firm conclusions have been reached (see Warwick & Salkovskis, 1990; Hiller *et al*. 2002; Ferguson, 2005; Noyes, 2005; Marcus *et al*. 2007). Therefore, it has been argued that taxometric methods should be applied to address this question directly for health anxiety (Ferguson, 2005; Marcus *et al*. 2007). Taxometric methods represent a set of procedures designed to demonstrate the latent structure of a construct as either dimensional (i.e. distributed as a continuous variable, with individuals varying quantitatively from each other) or taxonic (i.e. individuals are differentiated into non-arbitrary groups or categories) (Meehl & Yonce, 1994; Meehl, 1995; Waller & Meehl, 1998; see Ruscio & Ruscio, 2004*a* for a review).

Dimensionality: implications for theory, research and practice

Ruscio *et al*. (2006) argue that whether or not a construct is dimensional or taxonic has important implications regarding the types of theoretical explanations offered for clinical and individual differences, as well as for the types of research methods and clinical practice used. Theoretically, a dimensional account implies the existence of additive multi-causal agents. By contrast, a categorical approach indicates the existence of either a single causal factor (e.g. single gene or threshold model) or multi-causal effects that produce a qualitative disjunction between taxons and compliments (e.g. emergenesis or developmental bifurcation). Clinically, a dimensional approach would mean a move towards empirically derived multiple divisions as a basis for differential diagnosis, rather than the use of arbitrary cut-offs (cf. Widiger & Trull, 2007). For research, a dimensional account implies using the full range of scores without splitting samples into 'cases' and 'non-cases' (cf. Marcus *et al*. 2004, 2006) and developing further dimensional psychometric assessments (Ruscio *et al*. 2006). Given these different implications, a direct test of the latent dimensional structure of health anxiety is required.

The dimensional debate in health anxiety

There is strong indirect evidence to support the position that health anxiety is dimensional. First, the same pattern of effects for health anxiety is observed on a variety of outcomes in both clinical and non-clinical samples (Marcus *et al*. 2007). This indicates that the theoretical models apply across the range of scores observed for health anxiety. Second, a number of

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individual differences (worry, depression, anxiety, attachment style and impulsivity) that are theoretically and empirically related to health anxiety (Kellner, 1986; Ferguson, 2000, 2004) have been shown to have dimensional structures (Ruscio *et al*. 2006).

The indirect evidence supporting a categorical approach is much weaker. There are taxometric data showing that the tendency to over-report symptoms, a characteristic of health anxiety, is taxonic (Strong *et al*. 2000, 2006). However, the work reported by Strong *et al*. (2000, 2006) focused on psychiatric symptoms rather than somatic symptoms and may reflect an impression of management style rather than a tendency to over-report due to somatic awareness (Barsky, 1979). There is evidence that aspects of health anxiety symptomatology have a distinct boundary with other somatoform disorders (Fink *et al*. 2004). However, the existence of a boundary between disorders does not preclude that the disorder itself may be dimensional (Ruscio & Ruscio, 2004*b*; De Boeck *et al*. 2005).

Importantly, although the evidence for a categorical model is weak and a dimensional model is strong, it is still common practice in the literature to split samples into cases and non-cases using either psychometric measures or clinical schedules (e.g. Barsky *et al*. 1986; Brown *et al*. 1999; Hadjistavropoulos *et al*. 2000; see Marcus *et al*. 2007 for a review). The use of both categorical and dimensional approaches to health anxiety has been advanced (Hiller *et al*. 2002). Given the very different implications for theory development, research and clinical practice afforded by dimensional and categorical conceptualizations, a direct test of the dimensionality of health anxiety is required (see Ruscio *et al*. 2006).

Health anxiety versus *anxiety about actual illness*

Health anxiety represents the fears and worries about illness in the absence of objective illness (APA, 1994). People may report anxiety, depression and general psychiatric distress co-morbidly with actual illness (Haug *et al*. 1994; Gupta *et al*. 2001; Baune *et al*. 2007), either during or following a diagnosis (Katon *et al*. 1999; Tedstone & Tarrier, 2003). There is evidence that a diagnosis is associated with increased somatic awareness (see Katon *et al*. 1999). In fact, there is evidence that, of those expressing worry about illness, approximately 50% have actual illness (see Looper & Kirmayer, 2001; Noyes *et al*. 2005). The psychological distress and somatic awareness associated with actual ill health needs to be distinguished from anxiety about health in the absence of actual illness. Therefore, taxometric analyses of health anxiety were conducted on individuals who were not currently receiving medical treatment.

Table 1. *The sample*

Variable	Total sample ($n=699$)	Healthy ($n=501$)
Age (years)	41.1 (10.2)	40.3 (10.3)
Sex (% female)	57	55
Health anxiety (1–5)	2.4 (0.6)	2.4 (0.6)
Work tenure (months)	128.6 (109.6)	125.3 (109.7)
Job tenure (months)	94.5 (73.4)	68.2 (74.0)

Values in parentheses are S.D.

Method

Sample and sampling

Following recommendations, the sample was not specifically targeted for health anxiety or designed to be a mixture of high, medium and low health anxious individuals (Ruscio & Ruscio, 2004*a*, *b*; Ruscio *et al*. 2006). Instead, a convenience sample of 711 UK employees from three private sector industries and two public (local government) sector services was recruited (see Table 1 for details). Complete data on indicators of health anxiety were available from 699 (98%) of these participants. This sample was screened for those who were currently receiving medical treatment, and a sample of 501 subjects who were not currently undergoing medical treatment was classified as healthy. Although the same pattern of results was observed for the full sample of 699 participants, the results for the healthy 501 participants are reported as these meet a classic definition of health anxiety[1]†.

Measures

Health anxiety

The nine-item version of the Whiteley Index (WI; Barsky *et al*. 1986), scored on a five-point Likert-type scale (Barsky *et al*. 1990), was used to assess health anxiety and it has been found to have a test–retest reliability of 0.73 (Ferguson, 2004). This index was chosen for the following three reasons. First, it is a standard, reliable and valid index of health anxiety that covers the conceptual range of the construct (see Barsky *et al*. 1986, 1990; Ferguson, 2000, 2004; Ferguson *et al*. 2007). Second, items (referred to as indicators in taxometric analyses) need to be able to distinguish cases from non-cases (Meehl, 1995). When indexed to range from 1 to 5, the WI has been shown to differentiate cases from non-cases (see Barsky *et al*.

† The notes appear on p. 283.

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1990). Third, each item on this index is scored on a five-point Likert-type scale. Likert-type scaling, compared to dichotomous scoring, increases the power of taxometric analyses (Ruscio & Ruscio, 2004*a*, *b*). This version of the WI was adopted as it covered the conceptual nature of the construct, can be scored to differentiate cases from non-cases and is scored on Likert-type scales. The wording of the nine items was taken directly from Barsky *et al*. (1986). Items 1–3 reflect the highest three loading items for disease conviction, items 4–7 reflect the four highest loading items for disease phobia and items 8 and 9 reflect two of the three highest loading items for bodily preoccupation as originally described by Pilowsky (1967). The nine items therefore include the main indicators of health anxiety as defined by Pilowsky (1967)[2].

Screening current medical status

There is evidence to support the use of self-reported medical histories as a reliable way to establish health status (Bradford *et al*. 1993; Biossonnault & Badke, 2005) as well as physician and out-patient utilization (Cleary & Jette, 1984; Ungar & Coyte, 1998). For example, Cleary & Jette (1984) reported an average discrepancy (reported minus actual) of 0.05 visits over a 1-year period. Participants therefore answered two dichotomous items (YES or NO) derived from Ungar & Coyte (1998) to indicate their current out-patient and general practitioner (GP) utilization: (1) Are you currently receiving any out-patient treatment? and (2) Are you currently being treated by your GP for any illness? An answer of NO to both of these questions meant that the individual was defined as healthy.

Taxometric procedures

The taxometric procedures adopted conformed to the recommendations made by Ruscio & Ruscio (2004 *a*, *b*) and Ruscio *et al*. (2006). A large sample, not selected on predefined criteria (e.g. scoring high on measures of symptom reporting), was recruited. Selecting on predefined criteria may lead to false taxa (known as pseudo-taxa) that reflect the method rather than the existence of a true taxon (see Ruscio & Ruscio, 2004 *a*, *b*). To increase statistical power, indicators were selected that were scored as continuous scales. The following sequence of analyses were undertaken to ensure that the indicators: (1) covered the conceptual range of the construct, (2) had low nuisance covariance, (3) were valid and demonstrated good ability to discriminate any potential taxon (disordered group/cases) from complement (non-disordered group/non-cases) and (4) had minimal skew (Ruscio & Ruscio, 2004 *a*; Ruscio *et al*. 2004). Initially, indicator validity was examined. Indicators should be able to distinguish taxonic cases from their complement and Meehl (1995) has suggested that valid indicators should have a mean separation of 1.25 standard deviations (S.D.). Second, indictors that had high item–total correlations were chosen to represent the most valid indicators of the construct (Ruscio & Ruscio, 2004 *a*). Based on the indicators identified through these two steps, evidence for nuisance covariance was explored by examining the mean inter-indicator correlations in the upper and lower quartiles of the construct and in any potential complement and taxonic groups. For nuisance covariance to be tolerable, this should be less than 0.30 (Meehl, 1995). Positive skew can lead to the identification of pseudo-taxa with a small base rate, whereas negative skew can misidentify a high base rate taxon (see Ruscio *et al*. 2004). Therefore, it is necessary to report values of skew to enable interpretation of the data. Furthermore, the programs used compare taxometric curves derived from the actual data to simulated curves. The simulated curves are derived from the actual data characteristics, including skewness, allowing a contextualized interpretation of the results and helping to avoid the identification of pseudo-taxa (Ruscio *et al*. 2006).

Taxometric analysis

Taxometric analysis was implemented using the programs developed by Ruscio and colleagues (see Ruscio & Ruscio 2004 *a*, *b*; Ruscio *et al*. 2006; see also www.taxometricmethod.com/). The appropriately identified indicators were submitted to mean above minus below a cut (MAMBAC; Meehl & Yonce, 1994), maximum eigenvalue (MAXEIGEN; Waller & Meehl, 1998) and L-mode factor analysis (L-MODE; Waller & Meehl, 1998). Details of these techniques are described in the references above and in general by Ruscio & Ruscio (2004 *a*, *b*) and Ruscio *et al*. (2006). The basic rationale behind these procedures is to divide the sample along successive divisions of an input indicator and then calculate the mean difference in scores (based on the remaining indicators) above and below a cut (MAMBAC) or dividing cases into successive overlapping (90%) windows and calculating the first eigenvalue from the covariance of the remaining variables. Cuts along the indicator are presented on the *x* axis and mean differences or eigenvalues on the *y* axis. For dimensional solutions curves will be either concave (MAMBAC, MAXEIGEN) or flat or irregular (MAXEIGEN) but will be peaked for both techniques for a taxonic solution. L-MODE uses factor analytic procedures on all of the indicator variables to calculate scores on the first principal component and the distribution of these is plotted. A unimodal distribution

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indicates a dimensional solution and a bimodal distribution a taxonic solution. The MAMBAC models were based on 50 evenly spaced cuts. The MAXEIGEN analyses were based on 50 windows with 90% overlap.

Data analyses were conducted using taxometric programs developed by Ruscio *et al*. (2006). These programs have two important features to aid the interpretation of the data: (1) graphical comparison of observed *versus* simulated data and (2) calculation of fit indices to distinguish dimensional from taxonic solutions. Based on the distributional and correlation structures observed in the actual data, these programs generate simulated taxonic and dimensional data. The programs compare the curves for the simulated and actual data to produce a root mean square residual (RMSR). The smaller the RMSR, the better the observed curve fits the curve generated from the simulated data. By producing multiple simulated taxonic and dimensional data sets, it is possible to calculate the average RMSR and its S.D. An index similar to Cohen's *d* (Fit_d) is calculated by subtracting dimensional fit from the taxonic fit. Positive values indicate a dimensional structure and negative values a taxonic structure. Recently, Ruscio *et al*. (2006, 2007) have developed the curve comparison fit index (CCFI), which is based on the RMSR fits. The CCFI varies between 0 and 1 and is symmetric around 0.5. Values above 0.5 indicate a taxonic solution and <0.5 a dimensional solution. Ruscio *et al*. (2007) reported that Monte Carlo studies show that the CCFI more accurately distinguishes taxonic from dimensional solutions than traditional indices such as the Goodness of Fit Index (GFI; Waller & Meehl, 1998) and the base rate S.D. As such, the Fit_d and the CCFI are reported to aid interpretation along with the visual representations derived from the MAMBAC, MAXEIG and L-MODE curves[3].

Results

Representativeness of the sample

The taxometric analyses were applied to the sample of 501 participants who were classified as healthy (answered NO to both of the screening questions). The basic sample demographics for the whole sample and the 501 participants used in these analyses were generally representative of the UK population, which has a mean age of 39 years and is 51% female (Office for National Statistics) (see Table 1). There is inconsistent evidence with respect to the relationship between health anxiety and age or sex (Barksy *et al*. 1991; Noyes, 2005; Noyes *et al*. 2005). For these data, health anxiety (as indexed by both the original nine-item WI and the six-item version of the WI used in the taxometric analyses) was unrelated to age (both r's $=$ 0.04, both p's $=0.69$) and only marginally associated with sex (all t's >2.5, all p's <0.01), with women, compared to men, scoring marginally lower on both the full (22.6 *v*. 21.6) and six-item (14.4 *v*. 13.4) versions.

Barsky *et al*. (1990) reported that patients with clinical hypochondriasis scored on average 3.31 when the WI is averaged to range from 1 to 5. The healthy sample of 501 participants was split into 'cases' (those with a score $\geqslant 3.31$) and 'non-cases' (those who score <3.31). This split indicated that 6.6% were classed as 'cases', a figure that is consistent with previous reports for health anxiety in non-clinical samples (Noyes *et al*. 2000; Looper & Kirmayer, 2001; Rief *et al*. 2001).

Selection of indicators

For the sample of 501 healthy participants, the coefficient α for the full nine-item version of the WI was 0.73. Initially, all nine items of the WI were screened for indicator validity using Ruscio *et al*.'s (2006) INDICATOR.DIST program. For these analyses the sample was split into cases and non-cases using the cut of 3.31 on the averaged nine-item version (cf. Barsky *et al*. 1990). The indicator validities (expressed in standard units as Cohen's *d*), item–total correlations and skew for each indicator are presented in Table 2. Indicators showed a degree of skew that was generally within the ranges reported for other taxometric studies (Ruscio *et al*. 2004, 2007). Three indicators had validities <1.25 (indicators 1, 7 and 9) and two (indicators 7 and 9) had unacceptable item–total correlations. When these three indicators were removed, the α for the remaining six indictors increased to 0.81. Based on these six indicators, the mean inter-indicator correlations in the bottom and top quartiles were 0.02 and 0.03 respectively and 0.42 for the full sample. The mean correlation in the putative taxon was -0.02, and 0.17 in the putative compliment. Thus, there was no evidence for nuisance covariance. This six-item index correlated 0.95 with the full nine-item scale, indicating that the six-item index covered the majority of the construct.

Taxometric analyses

The taxometric curves for the MAMBAC, MAXEIG and L-MODE analyses are shown in Figs 1–3 respectively. These figures show that the curves produced by the actual data are closer to the simulated dimensional rather than taxonic data curves, supporting a dimensional interpretation. Confirmatory support for

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Table 2. *Descriptive statistics for indicators*

	Cohen's *d* (validity)	Skew	Item–total correlation
(1) If I feel ill and someone tells me I am looking better, I become annoyed	1.00	0.15	0.40
(2) People do not take my illnesses seriously enough	1.25	0.19	0.47
(3) I am bothered by the idea that something serious is wrong with my body	1.70	0.42	0.63
(4) I worry about my health more than most people	1.69	0.64	0.67
(5) I am afraid of illness	1.57	0.20	0.54
(6) If a disease is brought to my attention (e.g. on TV, radio, the newspapers or by someone I know), I worry about getting it myself	1.57	0.90	0.52
(7) It is easy for me to forget about myself and think about all sorts of other things	0.73	0.69	0.08
(8) I am bothered by many aches and pains	1.26	0.25	0.47
(9) I am rarely aware of the various things happening in my body	0.55	−0.14	0.06

Standard error of skew = 0.11.

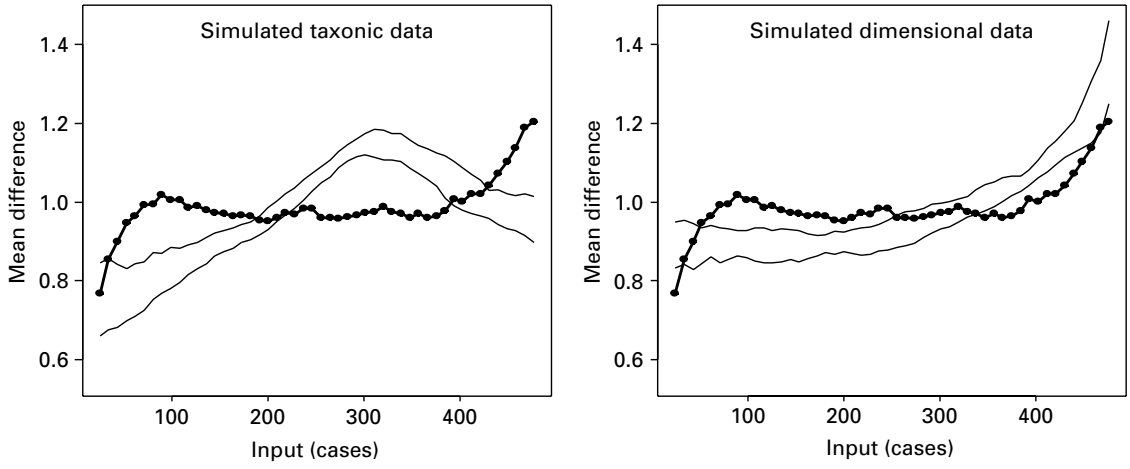

Fig. 1. MAMBAC (mean above minus below a cut) curves. Lighter smooth lines (—) show simulated data, the darker dotted line (●—●—●) the actual data. The two lighter smooth lines represent the distribution of the simulated data that are +1 S.D. and −1 S.D. from the average of all 10 simulated curves.

the dimensional representation is provided by the positive Fit_d values for the MAMBAC ($Fit_d = 4.15$) and MAXEIGEN ($Fit_d = 4.35$) analyses and CCFI values <0.50 for the MAMBAC (CCFI = 0.37) and MAXEIGEN (CCFI = 0.41) analyses.

Discussion

The pattern of results reported in this study indicates that health anxiety is better represented as a dimensional rather than a categorical construct (Warwick & Salkovskis, 1990). Within a dimensional conceptualization of health anxiety, individuals differ quantitatively across a dimension, with hypochondriasis marking an extreme of this distribution. These findings have a number of implications for theory and clinical utility.

Theoretical implications

A dimensional conceptualization of health anxiety has three main theoretical implications. The first implication concerns the development of theoretical models, suggesting that these should focus on additive multi-causal agents or risk factors (Ruscio *et al*. 2006: see also Meehl & Golden, 1982). As such, integrative models of health anxiety should be developed that include: (1) a number of potential risk factors (e.g. life stress, family medical history, and attachment styles: see Noyes *et al*. 2003, 2004), (2) cognitive/perceptual processing (Barksy *et al*. 1993; Pauli &

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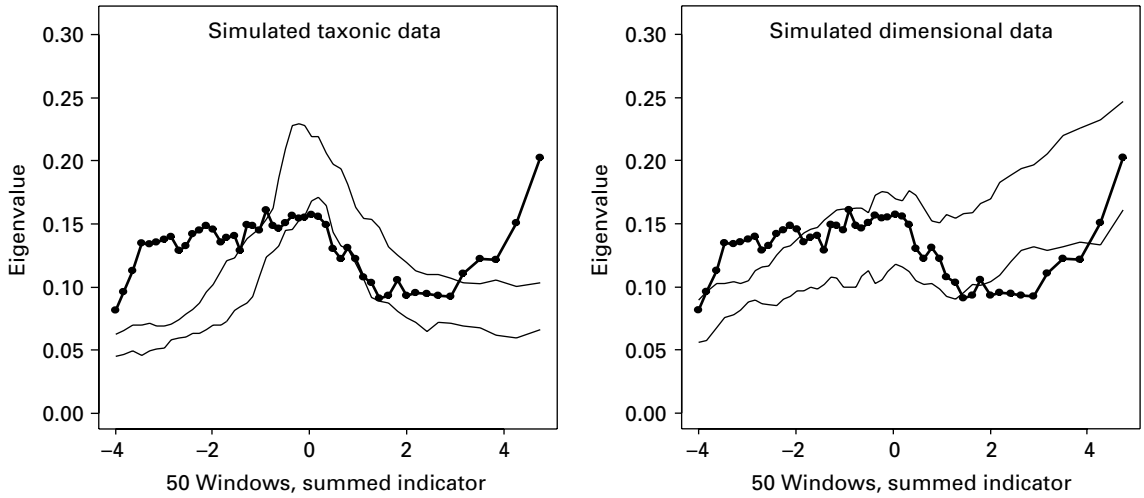

Fig. 2. MAXEIGEN (maximum eigenvalue) curves. Lighter smooth lines (—) show simulated data, the darker dotted line (-●-●-) the actual data. The two lighter smooth lines represent the distribution of the simulated data that are +1 S.D. and −1 S.D. from the average of all 10 simulated curves.

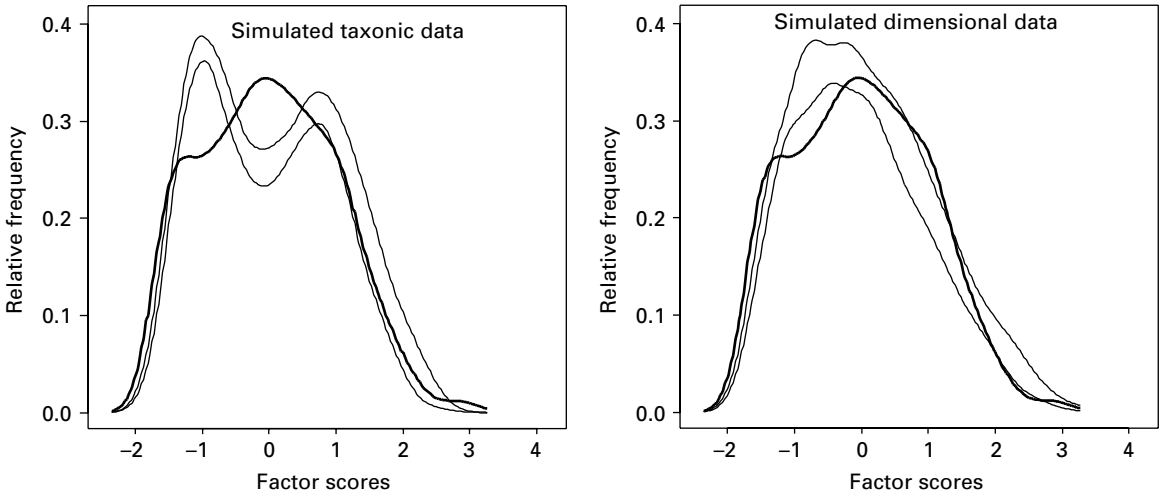

Fig. 3. L-MODE (L-mode factor analysis) curves. Lighter smooth lines (—) show simulated data, the darker, thicker line (—) the actual data. The two lighter smooth lines represent the distribution of the simulated data that are +1 S.D. and −1 S.D. from the average of all 10 simulated curves.

Alpers, 2002; Ferguson *et al*. 2007), (3) traits including somatosensory amplification, neuroticism, extraversion, health attributions and attachment style (Barsky, 1979; MacLeod *et al*. 1998; Ferguson, 2000; Waldinger *et al*. 2006) and (4) biological processes (Ferguson, 2005, 2008). Such models should take a longitudinal developmental perspective examining the reciprocal relationship between potential triggers (risk factors and traits) and maintenance (cognitive processes and biological mechanisms) factors. This work should be supplemented with experimental and quasi-experimental work to clarify causal relationships. Second, as health anxiety is continuously distributed within a population, these theoretical models should be examined using large unselected samples without having to specifically examine clinical 'cases' (Ruscio *et al*. 2006). This also has the advantage of increasing statistical power (Cohen & Cohen, 1983). Third, psychometric and clinical assessments of health anxiety should be further developed based on continua. Such measures should include items that reflect as wider a range as possible of potential symptoms and be capable of making fine-grained discriminations (Ruscio *et al*. 2006).

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Clinical implications

Clinicians argue that a dimensional approach does not have clinical utility. Specifically, they argue that dimensional scores cannot be used to make a diagnosis and, as such, a dimensional approach does not have clinical utility over existing categorical systems. Recently, Widiger & Trull (2007) have addressed this issue with the example of IQ. IQ is a dimensional construct that can be used to define individuals with scores <70 and direct therapeutic interventions at this group. Similarly, subtests from IQ batteries can be used to identify potential early memory and attention problems, relative to accepted norms, for those at risk of dementia. Indeed, Ruscio *et al*. (2006) argue that it is appropriate to draw distinctions within a latent dimensional construct as long as these are systematic and empirically justifiable based on the distributional nature of the measure. This approach is similar to the use of continuous diagnostic signs in physical medicine (e.g. blood pressure, heart rate, temperature, blood sugar) that are reasoned with using a number of meaningful distinctions to reach a final differential diagnosis. The challenge, which is beyond the scope of this paper, is to develop useful clinical diagnoses treating health anxiety as a continuum. One way to achieve this with a dimensional construct is to identify 'inflection points' where health rapidly worsens (Kessler, 2002) or to conduct sensitivity and specificity analyses to identify clinical cut-offs (Fink *et al*. 1999: see Ruscio *et al*. 2006 for other strategies).

Finally, the dimensional conceptualization means that it is possible to perform early stage clinical trials (stages 1 and 2) using regression approaches with large unselected samples that represent the range of scores on an index of health anxiety. In this way, early potential therapeutic effects for health anxiety can be identified prior to larger scale trials.

Caveats

The sample was based on a working population. This may lead to questions about the generalizability of the findings. However, the sample is generally representative of the UK general population. It may also be argued that the indicators used do not represent the whole construct of health anxiety. With respect to this, the measure used is a widely used standard, reliable and valid index of health anxiety and shown to be able to differentiate cases from non-cases (Barksy *et al*. 1986) and the six indicators used showed a high correlation with the full scale. Finally, this study examined the dimensionality of health anxiety in those without illness. However, it has been noted that in those who worry about illness, approximately 50% will have an actual illness (Looper & Kirmayer, 2001; Noyes *et al*. 2005). This study, therefore, did not address the dimensionality of health anxiety in those with a current illness. However, the taxometric analyses of the whole sample (including both those with and without current illness) supported the dimensional model. The sample size for those with illness ($n = 198$) was too small to conduct a taxometric analysis. Therefore, replications of these findings using different indicators and across sample of those with and without a current illness would be welcome.

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Declaration of Interest

None.

Notes

[1] The analyses were also completed on the full sample of 699 participants. The results replicated those reported here on the sample of 501 participants, showing that health anxiety has a dimensional structure. The Curve Comparison Fit Index (CCFI) for the 699 participants was 0.28 for the mean above minus below a cut (MAMBAC) procedure and 0.37 for the maximum eigenvalue (MAXEIGEN) procedures. The Fit_d figures were 6.78 and 4.39 respectively for the MAMBAC and MAXEIGEN procedures.

[2] Compared to the original Whitely index (WI), the wording of item 9 is reversed. This follows the wording presented by Barsky *et al*. (1986) and reduces potential acquiescence response set.

[3] Fit_d values were calculated using an earlier version of Ruscio's programs from 2004 and the CCFI using a more recent version (Ruscio *et al*. 2006). The taxometric curves reported are produced by the recent 2006 version of the programs.

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