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Correlates of perceptual distortions in clinical and non-clinical populations using the Cardiff Anomalous Perceptions Scale (CAPS): Associations with anxiety and depression and a re-validation using a representative population sample

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ABSTRACT

Although the literature on hallucinations in psychiatric patients shows clear links with anxiety and depression, associations of affect with a wider array of anomalous perceptual experiences have been much less studied. This study investigated patients with psychosis ($N=29$) and a non-clinical population ($N=193$) using the Cardiff Anomalous Perceptions Scale (CAPS), a measure of perceptual distortion and associated distress, intrusiveness and frequency; along with measures of depression, anxiety and worry. The study also allowed a re-validation of the CAPS in a more representative sample of the UK population. Moderate, reliable correlations with depression, anxiety and worry were found in the non-clinical population with the association being stronger in psychotic patients. The study re-confirmed that anomalous perceptual experiences are common in the general population and that a significant minority (11.9%) have higher levels than the mean of psychotic patients. Scale reliability and validity were also re-confirmed, and the CAPS score was found to be unrelated to age or gender in either sample. As in the original study, factor analysis produced a three-factor solution, although factor theme was not fully replicated: as before, a cluster of first-rank symptoms emerged, but with equivocal evidence for a temporal lobe factor and no replication of a 'chemosensation' component.

1. Introduction

Although 'anomalous perceptions' are most commonly characterised as 'hallucinations' in psychology and psychiatry, this interpretation belies the fact that perceptual anomalies can take a number of forms including changes to sensory intensity, distortions of existing perceptions, and frank hallucinations. Owing to the fact that these changes may occur in a number of sensory modalities including those outside the traditional 'five senses' (such as proprioception and time perception) and that differences in insight may mean that not all participant are aware that they are experiencing such changes, many current scales do not fully capture the full range of the phenomena (Bell et al., 2010). The Cardiff Anomalous Perception Scale (CAPS) was designed as a comprehensive self-report scale assessing the distress, intrusiveness and frequency of perceptual distortions, and it is the first scale to use multiple dimensional measures intended to capture a range of perceptual distortions in all major sensory modalities.

High levels of reliability and validity were demonstrated in its initial validation study with 336 general population participants, drawn largely from a student sample, and 20 inpatients with psychosis (Bell et al., 2006a). The scale is being increasingly used in psychosis continuum research, for example, in work indicating that pathological levels of self-reported anomalous perceptual experience are not necessary for the presence of delusions (Bell et al., 2008), that hallucination-prone individuals have reduced electrophysiological responses to ambiguous stimuli (Schwartzman et al., 2008) and that CAPS score predicts paranoid reactions in virtual reality (Freeman et al., 2008a) and can distinguish between the occurrence of paranoia and social anxiety (Freeman et al., 2008b). Furthermore, a recent study has applied the scale in an investigation looking at the continuum of out of body experiences in the general population (Braithwaite et al., 2011).

Freeman et al. (2010) have recently used the CAPS in a community sample ($N=200$) broadly representative of the UK population in socioeconomic status, and in a clinical group of patients with persecutory delusions in the context of a psychotic illness ($N=30$). This study focussed on explaining paranoia, but allows, by way of a secondary analysis, a further investigation into the relationship

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between anomalous perceptual experiences, as measured by the CAPS, and measures of anxiety, depression and worry. Additionally, the dataset allows a re-validation of the CAPS, to see whether the measure maintains its psychometric properties in the general population and with another clinical psychosis group.

Recent models of psychosis have cited 'neurotic' symptoms as a key part of both the development and maintenance of psychotic symptoms (e.g. Bentall et al., 2001; Garety et al., 2001; Bell et al., 2006b; Paulik et al., 2006; Freeman, 2007) and empirical studies have reported a strong link between anxiety and hallucinatory experiences, indicating that hallucination proneness is linked to trait anxiety (e.g. Allen et al., 2005) and that in psychotic individuals acute anxiety is linked to an increase in hallucinatory experience (e.g. Delespaul et al., 2002). Numerous studies have now linked depression to the positive schizotypy (review in Barrantes-Vidal et al., 2009) and although the relationship between hallucinated voices and depression was initially thought to be unidirectional (Verdoux et al., 1999), more recent evidence suggests the association is more complex with emotional distress linked to interaction and perceived relationship with the voice (Sorrell et al., 2010). Research with psychiatric inpatients (Serper and Berenbaum, 2008) has additionally suggested that reduced emotional clarity is related to more severe hallucinations in all patients, with reduced attention to emotion also related to increased hallucinatory experience in schizophrenia spectrum patients. Previous studies with non-clinical populations have found a link between these constructs and while the interactions are typically more complex (e.g. Kerns, 2005; Berenbaum et al., 2006; Berenbaum et al., 2009) they serve to highlight the importance of affect in hallucination formation.

On this basis we predict that 'neurotic' symptoms, and anxiety in particular, will be associated with elevated levels of anomalous perceptual experiences. Schizotypy, delusional ideation and hallucination proneness have been previously found to be inversely related to age in the general population (Young et al., 1986; Verdoux et al., 1998; Mata et al., 2005) with females scoring higher on perceptual distortion measures (Young et al., 1986; Mata et al., 2005; Scott et al., 2008). With this in mind we also took the opportunity to explore the links between CAPS score, gender and age in this sample.

Furthermore, perceptual anomalies vary greatly in type, and therefore the initial validation study used a principal components analysis to examine groupings of perceptual distortions, deriving three non-overlapping factors (Bell et al., 2006a). These were provisionally labelled as 'clinical psychosis' (largely Schneiderian first-rank symptoms such as), 'temporal lobe disturbance' (largely related to experiences such as that have been linked to non-psychotic temporal lobe epilepsy and related seizure-like disturbances) and 'chemosensation' (largely olfactory and gustatory experiences such as anomalous smells or tastes). Although exploratory factor analysis can vary from sample to sample, the current study allowed a further factor analysis of a more representative population sample.

2. Method

2.1. Participants and procedure

2.1.1. General population

The data were drawn from an experimental study examining the occurrence of persecutory ideation in the general population (Freeman et al., 2008a; 2008b). These studies only reported the total CAPS score (the number of items endorsed) as one of several variables and, therefore, this study provides a fuller and more detailed analysis of the properties of the CAPS for this sample. A total of 200 adults from the general population were recruited via leaflet distribution, advertising a study of "people's reactions in virtual reality" that was sent to all households in local postcodes. Individuals were interviewed on first meeting and those who noted a history of severe mental illness were excluded from the study.

We excluded seven participants from the analysis who missed items on the questionnaires or excluded even a single item of demographic information, leaving a total of 193 general population participants included in the final analysis. Demographic information for the sample is shown in Table 1.

Table 1
Demographics of non-clinical and patient participants.

	Age			IQ		
Participants	Mean	S.D.	Range	Mean	S.D.	Range
Non-clinical						
Males (95)	37.06	13.57	18–77	106.25	11.11	77–133
Females (98)	37.85	13.01	18–75	103.49	12.71	69–127
Total (193)	37.5	13.3	18–77	104.85	12.0	69–133
Patients						
Males (18)	41.78	10.87	22–65	–	–	–
Females (11)	47.28	12.87	21–65	–	–	–
Total (29)	44.86	11.76	21–65	–	–	–

Distributions of socioeconomic class according to the UK National Statistics Socio-Economic Classification system was as follows: higher professional occupations 7.8%, lower managerial and professional occupations 29.0%, intermediate occupations 8.8%, small employers and own account workers 6.2%, lower supervisory and technical occupations 3.6%, semi-routine occupations 8.3%, routine occupations 6.2%, never worked and long term unemployed 17.1%, students (not officially classifiable) 13.0%. The ethnic groupings within the non-clinical sample were as follows: White 67.4% ($n=130$), Black Caribbean 8.3% ($n=16$), Black African 4.7% ($n=9$), Indian 3.1% ($n=6$), Black Other 2.6% ($n=5$), Pakistani 0.5% ($n=1$), and Other 13.5% ($n=26$). In comparison to the original validation sample reported by Bell et al. (2006a) where 85% of the participants were drawn from a student population, it is notable that this sample was considerably more representative of the general population.

All general population participants completed a series of assessments related to a cognitive model of persecutory delusions, which are detailed in full in Freeman et al. (2008a; 2008b). However, only results from the Cardiff Anomalous Perceptions Scale (CAPS: Bell et al., 2006a), the Depression Anxiety Stress Scales (DASS; Lovibond and Lovibond, 1995), the Penn State Worry Questionnaire (PSWQ; Meyer et al., 1990), and the Wechsler Abbreviated Scale of Intelligence (Wechsler, 1999) are reported here.

2.1.2. Clinical

The clinical population data were taken from Freeman et al. (2010). Thirty patients with a diagnosis of non-affective psychosis completed the same assessments, with the exception of intellectual functioning. One patient was excluded as having missed some CAPS items. Patients were recruited from community mental health teams and inpatient units within the South London and Maudsley NHS Foundation Trust. Participants had to be currently experiencing a persecutory delusion meeting the criteria outlined by Freeman and Garety (2000). Participants had to have a diagnosis of schizophrenia, schizoaffective disorder or delusional disorder but were excluded if they had a history of epilepsy. The case-note diagnoses of those recruited were: schizophrenia ($n=23$), schizoaffective disorder ($n=4$) and delusional disorder ($n=2$). Delusion conviction was rated on a 0–100% scale. The mean level of belief conviction was 88.0% (S.D. = 18.3). Severity of paranoid ideation was additionally rated using the persecutory thought subscale of the Green et al. Paranoid Thought Scales (Green et al., 2008) a validated psychometric scale based on the Freeman and Garety (2000) criteria. Mean persecutory thought score was 65.59 (S.D. = 13.61), mean persecutory thought conviction score was 16.69 (S.D. = 3.31), mean persecutory thought distress score was 16.76 (S.D. = 3.39) and mean persecutory thought preoccupation score was 15.93 (S.D. = 4.33) all of which were above the mean scores of the clinical group used in the original validation study (Green et al., 2008) additionally indicating the presence of firmly held persecutory delusions.

The ethnic groupings within the clinical sample were as follows: White 51.7% ($n=15$), Black African 10.3% ($n=5$), Black Caribbean 10.3% ($n=3$), Black Other 10.3% ($n=3$), Indian 3.4% ($n=1$), and Other 6.9% ($n=2$). Distributions of socioeconomic class according to the UK National Statistics Socio-economic Classification system were as follows: lower managerial and professional occupations 3.4%, intermediate occupations 13.8%, semi-routine occupations 3.4%, routine occupations 3.4%, never worked and long term unemployed 72.4%, and students (not officially classified) 3.4%. A comparison of the distribution of males and females in the clinical and non-clinical groups using a chi-square indicated that the distribution was not significantly different from chance ($\chi^2=1.665$, $p=0.197$) suggesting the groups were evenly balanced for gender.

2.2. Measures

The CAPS (Bell et al., 2006a) is a 32-item scale asking about a range of anomalous perceptual experiences to which respondents respond in a yes/no fashion. A 'yes' response requires the participants to rate the experience on subcales for intrusiveness, frequency and distress on a 5-point scale, giving a total score range of 0 to 32 and a subscale range from the total score to five times the total score. As well as including these dimensional measures, the CAPS includes a comprehensive range of perceptual anomalies, including the classic 'five senses' as well as proprioception, time perception, somatosensory, body image distortion, sensory flooding and changes in perceptual

Table 2
CAPS means and standard deviations (in brackets) of the general population and patient sample using the original scoring method.

	CAPS Subscales			
Group	Total	Distress	Intrusiveness	Frequency
Non-clinical				
Males ($n=95$)	6.53 (5.77)	11.24 (12.46)	14.08 (14.73)	11.95 (12.92)
Females ($n=98$)	8.28 (6.59)	16.08 (14.41)	18.22 (17.01)	16.99 (17.02)
Total ($n=193$)	7.41 (6.24)	13.70 (13.67)	16.19 (16.03)	14.51 (15.31)
Patients				
Males ($n=18$)	15.56 (8.23)	54.56 (34.33)	56.06 (34.49)	49.33 (29.34)
Females ($n=11$)	16.64 (8.23)	66.00 (39.40)	64.91 (38.82)	62.18 (41.47)
Total ($n=29$)	15.97 (8.17)	58.90 (36.08)	59.41 (35.77)	54.21 (34.31)

intensity. Items were drawn from both the psychiatric and neurological literature and the questions are posed in various ways to account for different forms of insight. For example, for each relevant experience the scale enquires whether it occurs as subjectively anomalous or 'unusual' experience, as a non-shared sensory experience, or an experience that has no obvious environmental source.

The Penn State Worry Questionnaire is a measure of trait worry style with 16-items to which the participants responds on a 5-point scale indicating how closely the described worry style is typical of themselves. The Depression Anxiety Stress Scales is a 42-item scale with three subscales measuring current symptoms of depression, anxiety and stress of which the depression and anxiety scales are used in this study. Each subscale has 14 items rated from 0 to 3 indicating how closely each item relates to the respondent. The Wechsler Abbreviated Scale of Intelligence is a brief test of IQ. The two subtest version (consisting of Matrix Reasoning and Vocabulary) was used in this study.

2.3. Analysis

The analysis aimed to establish the internal reliability of the CAPS using Cronbach's alpha and discriminant validity by comparing scale scores between the clinical and non-clinical groups using between-samples *t*-tests with correction for multiple comparisons. Unless otherwise stated, a Bonferroni correction was used for this purpose where the standard alpha of <0.05 was divided by four (for a comparison on each CAPS subscale) giving a corrected level of significance of <0.012. Relationships between CAPS scores and scores on the Penn State Worry Questionnaire, Depression Anxiety Stress Scales, and an opportunistic comparison with age were explored using Pearson correlations. Because the magnitude of Pearson correlations cannot be directly compared, Fisher's *Z* transformations were also calculated to allow inter-correlation comparisons. All analysis was completed with SPSS 15.0 for Windows (SPSS, Chicago, IL).

To better provide for the use of the CAPS in the assessment of individuals in clinical work (where comparison against a distribution is a standard method to provide the clinician with an estimate of where the score lies in comparison to the normal population) we also calculated the percentile distribution of CAPS subscales, so individual scores can be matched against the population distribution, particularly useful in this case as the sample is highly representative of the UK population. Additionally, a hierarchy analysis from Freeman et al. (2005) was completed to indicate whether the rarer experiences on the population level were most predictive of higher overall score on the individual level.

Our earlier study found a three-factor non-overlapping solution from a principal components analysis (PCA) conducted using data from the non-clinical sample. We re-ran an identical three-factor confirmatory analysis on the entire non-clinical sample to see whether the same factor structure would appear. For all analyses, the CAPS Total items were entered into the PCA using the oblique rotation (oblimin) procedure. An oblimin rotation was used since it assumes that the underlying factors are not necessarily independent from each other, which may often be the case in perceptual experience (for example, olfactory and gustatory experiences being strongly linked).

3. Results

3.1. Reliability

Cronbach's alpha was used as a measure of internal reliability and in the non-clinical sample the CAPS displayed excellent internal reliability for: CAPS Total Score (alpha = 0.89), CAPS Distress (alpha = 0.89), CAPS Intrusiveness (alpha = 0.89), and CAPS Frequency (alpha = 0.91).

3.2. Validity

As can be seen in Table 2, and as found in the original validation study, the patient sample had significantly elevated scores on all CAPS subscales. Analyses using independent samples *t*-test analysis found that all differences were significant and calculation of Cohen's *d* showed large effect sizes for all differences, none smaller than 1.21: CAPS Total Score ($t_{(220)}=6.59$; $p<0.0001$; 95% CI = 5.99–11.11; $d=1.17$), CAPS Distress ($t_{(220)}=12.52$; $p<0.0001$; 95% CI = 38.08–52.31; $d=1.66$), CAPS Intrusiveness ($t_{(220)}=11.03$; $p<0.0001$; 95% CI = 35.51–50.95; $d=1.56$), CAPS Frequency ($t_{(220)}=10.59$; $p<0.0001$; 95% CI = 32.31–47.09; $d=1.49$).

3.3. Relationship to depression, anxiety and worry

With respect to measures of depression, anxiety and worry, results from correlations are displayed in Table 3. In the general population, all of these measures of 'neurotic' symptoms correlate weakly to moderately with all CAPS subscales with a high level of significance. These results are reflected in the clinical group, where similarly significant but moderate to strong relationships are found between scores on all CAPS subscales. This is clearest for the relationship with anxiety, which remains the strongest in both clinical and non-clinical groups.

3.4. Relationship to age

The relationship between age and anomalous perceptual experience was examined using Pearson correlations. All relationships in the non-clinical population were either non-significant or of minimal effect and none survived Bonferroni correction (corrected alpha of 0.05/4 subscales = 0.012) for multiple comparisons (CAPS Total Score: $r=-0.078$, $p=0.284$; CAPS Distress: $r=-0.139$, $p=0.055$; CAPS Intrusiveness: $r=-0.151$, $p=0.036$; and CAPS

Table 3
Correlations between CAPS scores and DASS Depression and Anxiety scores and Penn State Worry score in both non-clinical and patient groups.

	DASS Depression			DASS Anxiety			Penn State Worry		
Groups	*r*	*Z*	*p*	*r*	*Z*	*p*	*r*	*Z*	*p*
Non-clinical									
CAPS Total	0.223	0.227	0.002	0.403	0.427	<0.0001	0.203	0.206	0.005
CAPS Dis	0.522	0.579	<0.0001	0.504	0.555	<0.0001	0.359	0.376	<0.0001
CAPS Int	0.290	0.299	<0.0001	0.443	0.476	<0.0001	0.314	0.325	<0.0001
CAPS Freq	0.270	0.277	<0.0001	0.437	0.469	<0.0001	0.202	0.205	0.005
Patients									
CAPS Total	0.613	0.714	<0.0001	0.750	0.973	<0.0001	0.511	0.564	0.005
CAPS Dis	0.608	0.706	<0.0001	0.723	0.914	<0.0001	0.511	0.564	0.005
CAPS Int	0.611	0.711	<0.0001	0.686	0.840	<0.0001	0.522	0.579	0.004
CAPS Freq	0.647	0.770	<0.0001	0.736	0.942	<0.0001	0.517	0.572	0.004

r = Pearson correlation coefficient; *Z* = Fisher's *Z* transformation; *p* = statistical significance.

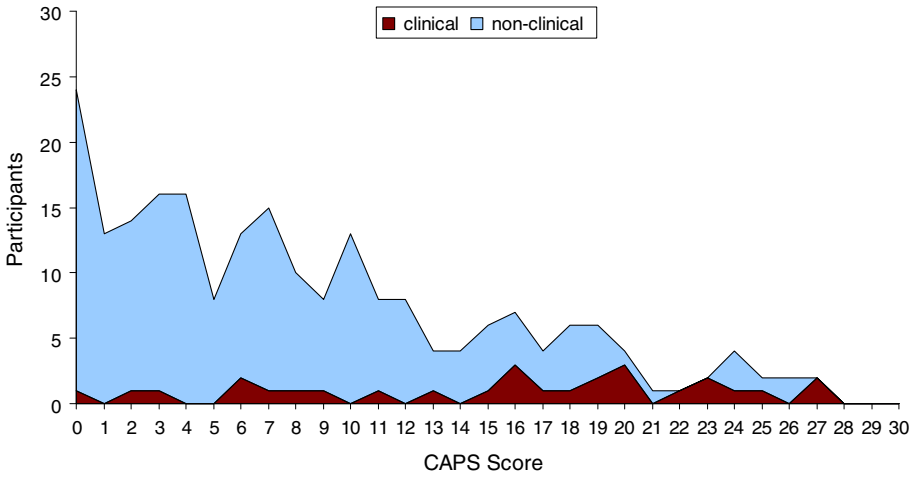

Fig. 1. Frequency distribution of the CAPS Total Score of clinical and non-clinical participants.

Frequency: $r = -0.069$, $p = 0.342$). There were no significant correlations between age and CAPS score in the clinical group (CAPS Total Score: $r = 0.044$, $p = 0.821$; CAPS Distress: $r = 0.03$, $p = 0.879$; CAPS Intrusiveness: $r = 0.021$, $p = 0.912$; and CAPS Frequency: $r = 0.158$, $p = 0.412$)

3.5. Sex differences

As can be seen from Table 2, females generally scored more highly on the CAPS than males. In the general population, this difference was initially significant when tested using two-tailed independent samples t-tests for CAPS Distress ($t_{(191)} = 2.493$; $p = 0.014$; 95% CI = 1.001–8.669; $d = 0.36$) and CAPS Frequency ($t_{(191)} = 2.313$; $p = 0.022$; 95% CI = 0.741–9.343; $d = 0.34$), although neither survived Bonferroni corrections for multiple comparisons. Similar analyses of sex differences between CAPS Total showed a marginally non-significant difference ($t_{(191)} = 1.96$; $p = 0.051$; 95% CI = 0.0113–5.509; $d = 0.28$), a finding reflected in the CAPS Intrusiveness results ($t_{(191)} = 1.26$; $p = 0.073$; 95% CI = 0.384–8.664; $d = 0.26$), which were marginal when a Bonferroni correction was applied. The lack of significant differences and small effect sizes suggests a lack of reliable sex difference on CAPS scores.

3.6. Frequency distribution

Fig. 1 displays the frequency distribution and range of scores for clinical and non-clinical participants, demonstrating, as with our original validation study, that the non-clinical population cuts across the entire range of the clinical population in terms of number of anomalous perceptual experiences reported. In this new study, 11.9% of the non-clinical sample scored above the mean of psychotic inpatients, closely matching the figure of 11.3% reported in the previous study (Bell et al., 2006a). The distribution of the scores from the non-clinical population broken down by percentiles is described in Table 4.

Using a hierarchical analysis from Freeman et al. (2005) it is also possible to see whether less common experiences on the sample level are associated with higher overall levels of anomalous experiences in those individuals (i.e. to what extent endorsing a particular experience predicts a higher overall score on the scale). For each item on the scale the average number of other items also endorsed was calculated, controlling for the presence of that item. The number of other items endorsed show a strong inverse correlation with the frequency of item endorsement ($r = -0.739$, $p = <0.0001$) indicating that the rarer the item in the population, the more strongly it predicted overall scale score. For example, endorsing the least frequent item "Have you ever heard two or more unexplained voices talking with each other? (frequency 1.6%) was associated with endorsing an average of 18.3 other items on the scale, while endorsing the most frequent item "Do you ever find that your experience of time changes dramatically?" (frequency 45.1%) was associated with endorsing an average of 10.1 other items on the scale.

3.7. Factor structure

The Kaiser–Meyer–Oklin value was 0.834, exceeding the recommended value of 0.6, and Bartlett's Test of Sphericity was significant ($p < 0.0001$), supporting the suitability of PCA with this data set.

Using a cutoff of 0.4 for factor loadings the PCA produced a clear three-factor solution (see Table 5) that explained 35.58% of the total variance. Although three factors emerged as in the original CAPS study (Bell et al., 2006a) the contents were not similar for all factors. The first factor in the current analysis contained a range of experiences that did not fit a unified theme, although they were broadly 'non-clinical' in that they tended to reflect less severe distortions of everyday sensory perceptions rather than frank hallucinatory experiences. A clear second 'clinical psychosis' factor, largely consisting of first-rank symptoms, did emerge and was analogous to the same factor found in the previous study. Supporting the distinction between the 'clinical' and 'non-clinical' nature of the first and second factors was the fact that mean distress scores from the clinical factor were significantly higher than those from the clinical factors (paired sample t-test, $t_{(193)} = 6.86$; $p = <0.0001$; 95% CI = 0.169 – 0.306; $d = 0.5$). The third factor, however, consisted of two items: "24. Do you ever have the feeling of being uplifted, as if driving or rolling over

Table 4
Percentiles for CAPS subscales scores.

	CAPS subscale scores			
Percentile	Total score	Distress	Intrusiveness	Frequency
10	0	0	0	0
20	2	2.8	3	2.8
30	3	4.2	6	4
40	4	7	8	6.6
50	6	10	11	9
60	8	12.4	15.4	12
70	10	17	20.8	18.8
80	12	24	27	25
90	17	33.6	38.6	35

Table 5
Factor structure for CAPS items in the non-clinical population. Factor loadings below 0.3 not shown.

Item	Component		
	1	2	3
18. Do you ever smell everyday odours and think that they are unusually strong?	0.67		
23. Do you ever have days where lights or colours seem brighter or more intense than usual?	0.67		
30. Do you ever notice that food or drink seems to have an unusual taste?	0.62		
25. Do you ever find that common smells sometimes seem unusually different?	0.61		
21. Do you ever think that food or drink tastes much stronger than it normally would?	0.60		
20. Do you ever find that your skin is more sensitive to touch, heat or cold than usual?	0.59		
29. Do you ever notice smells or odours that people next to you seem unaware of?	0.58		
27. Do you ever find that your experience of time changes dramatically?	0.57		
1. Do you ever notice that sounds are much louder than they normally would be?	0.57		
16. Do you ever find that sounds are distorted in strange or unusual ways?	0.54		
9. Do you ever have the sensation that your body, or a part of it, is changing or has changed shape?	0.50		
17. Do you ever have difficulty distinguishing one sensation from another?	0.49		
14. Do you ever experience unexplained tastes in your mouth?	0.47	0.33	
15. Do you ever find that sensations happen all at once and flood you with information?	0.46		
26. Do you ever think that everyday things look abnormal to you?	0.45		
8. Do you ever detect smells which don't seem to come from your surroundings?	0.45	0.30	−0.31
22. Do you ever look in the mirror and think that your face seems different from usual?	0.40		0.33
3. Do you ever hear your own thoughts repeated or echoed?	0.38		
5. Do you ever experience unusual burning sensations or other strange feelings in or on your body?	0.35		
28. Have you ever heard two or more unexplained voices talking with each other?		0.67	
12. Do you ever feel that someone is touching you, but when you look nobody is there?		0.62	
13. Do you ever hear voices saying words or sentences when there is no-one around that might account for it?		0.57	
7. Do you ever hear your own thoughts spoken aloud in your head, so that someone near might be able to hear them?		0.54	−0.37
11. Do you ever hear voices commenting on what you are thinking or doing?		0.51	0.40
4. Do you ever see shapes, lights or colours even though there is nothing really there?		0.47	
2. Do you ever sense the presence of another being, despite being unable to see any evidence?		0.44	
32. Do you ever hear sounds or music that people near you don't hear?		0.42	
6. Do you ever hear noises or sounds when there is nothing about to explain them?		0.33	
31. Do you ever see things that other people cannot?		0.32	0.31
24. Do you ever have the feeling that of being uplifted, as if driving or rolling over a road while sitting quietly?			0.63
10. Do you ever have the sensation that your limbs might not be your own or might not be properly connected to your body?			0.48
19. Do you ever find the appearance of things or people seems to change in a puzzling way, e.g. distorted shapes or sizes or colour?			0.37

a road while sitting quietly?" and "10. Do you ever have the sensation that your limbs might not be your own or might not be properly connected to your body?" Although, previously identified as relating to temporal lobe disturbance, other notable experiences that made up the factor originally identified in the Bell et al. (2006a) study were not present, suggesting that this factor was not fully replicated in this more representative sample.

4. Discussion

This study examined the properties of the CAPS in a broadly representative sample of the UK population and re-confirmed that the scale has good internal reliability and good discriminant validity providing additional evidence that the scale is a valid and reliable measure of anomalous perceptual experience. The data presented here confirm that anomalous perceptual experiences are common in the non-clinical population and that a significant minority have greater levels of perceptual distortion than patients with psychotic diagnoses. Furthermore, additional analyses demonstrated that CAPS score was not significantly related to age or gender in a non-clinical population or age or gender in a group of psychotic patients. However, reliable and moderate correlations between anomalous perceptual experience and 'neurotic' symptoms of depression, anxiety and worry were found in the non-clinical population and this relationship was greater in the sample of psychotic patients who demonstrated moderate to strong correlations, although owing to differing sample sizes it was difficult to make a direct comparison. As with the original validation study (Bell et al., 2006a) the factor analysis of the non-clinical population produced a three-factor solution. Although the factors were not broadly equivalent, a clear cluster of first-rank symptoms emerged in both analyses, and equivocal evidence for a temporal lobe factor emerged.

As regards to the reliability and validity of the scale, it is clear that the results of this study match the results of the original validation study very closely, even though the initial sample was largely drawn from a student population with the clinical sample drawn exclusively from inpatient wards; in comparison to the larger and more stratified population reported here who were a community sample and a mixed inpatient and outpatient group. This lack of substantial difference across groups, whose most salient difference was age, was supported by the lack of correlation between age and CAPS scores within the general population sample reported here. However, this was in contrast to previous studies which found age-related differences in levels of perceptual distortions and unusual beliefs with younger people reporting higher levels (van Os et al., 2000; González-Pinto et al., 2004). It is not clear exactly why this might be without further investigation, although it is noteworthy that two previous studies used clinical psychosis measures, while the CAPS was specifically designed to cover a wider range of experiences beyond the limited scope of assessment tools drawn from clinical psychiatry. However, it is also true that these earlier studies reported relatively weak effects in these areas and were on much larger population samples, suggesting that the present study may not have been sensitive enough to pick up such potentially subtle differences.

Although no reliable sex differences were found in CAPS scores, this was in contrast to the original validation study where females scored significantly higher. The literature on sex differences and perceptual distortion is mixed with some studies reporting reliable sex differences and others finding none. Notably, the most reliable sex differences seem to emerge when more general measures of psychosis proneness or schizotypy are used (Raine, 1992; Venables and Bailes, 1994; Mason et al., 1995), rather than when specific perceptual distortion measures are deployed where sex differences have not been reported (Ohayon, 2000; Aleman et al., 2001; Larøi et al., 2004; Paulik et al., 2006). There were also no significant differences in levels of anomalous perceptual experience across the different ethnic groups in the study, although the relatively small of people in the

non-white groups (e.g. 7 in the South Asian group) may have meant reliable differences, if present, were hard to detect.

In line with much previous research, this study confirmed a strong link between anxiety and perceptual distortion in both clinical and non-clinical populations (e.g. Ohayon, 2000; Delespaul et al., 2002; Morrison et al., 2002; Freeman and Garety, 2003). Due to the cross-sectional nature of the study, it was not possible to establish to what extent anxiety was a precursor to perceptual distortion rather than a result of it. While there is evidence about the role of attribution and evaluation in the likelihood of distress related to hallucinations (e.g. Birchwood and Chadwick, 1997; Gauntlett-Gilbert and Kuipers, 2005), there is no research we know of that has directly evaluated the effect of anxiety-induction on the likelihood of perceptual distortion, although there is evidence to suggest that acute anxiety raises levels of persecutory thinking in psychotic patients (Ellett et al., 2008). From the basis of existing models and evidence, we would expect a reciprocal relationship between anxiety and perceptual distortion although the exact nature of this relationship needs to be further explored.

In terms of the principle components, analysis, while three factors emerged, only the 'clinical psychosis' component appeared to be confidently equivalent to a similar factor identified by Bell et al. (2006a). While this does not affect the validity of the scale, it does have some implications for possible influences on the presentation of anomalous perceptual experiences. In the original study, it was noted that one particular factor seemed to reflect experiences related to temporal lobe disturbance and this was not fully replicated in the current study. The two main possibilities are that either the factor is not reliably present and the original finding was a coincidence, or that it was only present in groups of younger people and does not appear in an analysis that included participants from a wider age range. A second possibility is given some support from the clinical literature that temporal lobe seizure semiology differs over the lifespan (Fogarasi et al., 2007), although both hypotheses need to be specifically tested to draw strong conclusions. It is important to note that the presence or absence of a specific temporal lobe component in a factor analysis says little about the contribution of temporal lobe disturbance to anomalous experiences as a whole, simply that the phenomena may not form a distinct group of experiences. The true contribution of temporal lobe disturbance to the items drawn from temporal lobe phenomenology needs to be fully investigated with electrophysiological methods.

In the analysis, the original 'chemosensation' factor (largely taste and smell experiences) did not appear in this analysis, while the 'clinical psychosis' factor clearly did. This raises the intriguing possibility that 'first-rank symptoms' and their related experiences are qualitatively different from other forms of perceptual distortion. Contrary to purely dimensional models of psychosis (Claridge et al., 1995), which suggest that people who come into contact with clinical services differ in the intensity of their experiences and their coping styles, this suggests that specific types of anomalous experiences may be more likely to cause distress or impairment, something supported by the mean difference in distress levels found between the potentially clinical and non-clinical factors. Indeed, there are now a number of recent studies debating the factor structure of the Launay–Slade Hallucinations Scale and whether there are specific 'clinical' and 'non-clinical' factors that form the basis of experiences covered by the scale (Aleman et al., 2001; Waters et al., 2003; Larøi et al., 2004; Serper et al., 2005; Paulik et al., 2006). However, it is probably worth sounding a note of caution in that these studies have, with the exception of Serper et al. (2005), that included a clinical sample, been entirely based on non-clinical data from undergraduate student samples and may not apply to more representative population samples.

The population sample used in this study was both larger and more representative than the original study and although criterion and discriminant validity was confirmed on a new clinical sample, this study remains limited in that it was entirely cross-sectional, self-selecting and no replication of test–retest reliability could be conducted. This same limitation applies to the conclusions drawn with regard to age-differences, and further longitudinal research will need to be conducted on the course of anomalous through the lifespan to be able to confidently infer the existence of developmental changes. Furthermore, owing to the increasing awareness of the importance of age and type of onset of psychosis (e.g. Rhodes and Jakes, 2010) and treatment history on psychological factors (e.g. So et al., 2010), further studies will need to fully assess the impact of these variables on anomalous perceptual experiences.

However, the fact that the CAPS has been confirmed as a valid and reliable measure of anomalous perceptual experience and that this study has allowed the generation of clinical metrics for the assessment of individual patients will, we hope, put the scale on a good foundation for future work.

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