Journal of Vestibular Research 16 (2006) 223–231
IOS Press

The assessment of increased sensitivity to visual stimuli in patients with chronic dizziness

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Received 3 May 2006
Accepted 15 January 2007

Abstract. Patients with chronic vestibular dysfunction often experience visually-induced aggravation of dizzy symptoms (visual vertigo; VV). The Situational Characteristics Questionnaire (SCQ), Computerized Dynamic Posturography or Rod and Frame Test (RFT) are used to assess VV symptoms. This study evaluates whether correlations exist between these three tests, their ability to identify patients with VV and whether emotional state correlates with VV symptoms. Tests were completed by 20 normal controls (Group NC), 20 patients with vestibular dysfunction plus VV (Group VV) and 13 without VV (Group NVV). Additionally, the Vertigo Symptom Scale (VSS-V) was applied to quantify general, non-visually induced vertigo (dizziness, lightheadedness and/or spinning) and imbalance. Autonomic (VSS-A) and psychological symptoms (Hospital Anxiety and Depression questionnaire; HAD) were also assessed. With the SCQ 100% of Group VV scored outside normal ranges and scores differed significantly between Group VV and both Groups NC and NVV. RFT values were not significantly different between groups; only 15% of patients scored outside normal ranges. Posturography scores were abnormal for 50% of patients; significant differences were noted between Groups NC and VV for composite scores and ratios 3/1, 4/1, 5/1 and 6/1 (indicative of abnormal sensory re-weighting). There were no correlations between the three data sets in patients. Anxiety and depression scores significantly differed between Groups NC and VV but not between patient groups; this indicates that psychological symptoms may be present in either patient group. The SCQ can be used to corroborate an initial clinical diagnosis of VV and quantify its severity in patients with vestibular dysfunction. Posturography data suggested patients with VV have a sensory re-weighting abnormality. The rod and frame test results and posturography findings agree less with the clinical diagnosis of VV. Psychological symptoms may need to be addressed.

Keywords: Visual vertigo, posturography, rod and frame, vestibular rehabilitation

1. Introduction

Perceptual preferences for spatial orientation vary within the normal population with some individuals relying more on vision (visual field dependence) and others on vestibulo-proprioceptive cues [39]. Witkin and colleagues speculated that such individual differences might be related to gender, experience and personality variables [9,38,40]. In addition, visual dependency

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ISSN 0957-4271/06/$17.00

is reported for various patient groups including those with Parkinson's disease [1], following stroke [4], and in the elderly [5]. The present study is concerned with the presence of visual dependence and the presence of visually-induced dizziness (visual vertigo, VV) in patients with vestibular disorders.

Various authors have reported that some patients with a vestibular disorder are more susceptible to visual motion than others [7,16,24,25,29]. Patients with VV complain of discomfort, postural destabilization, and exacerbation of their symptoms in challenging visual environments (e.g. supermarket aisles, in crowds, watching moving scenes) [7]. These symptoms may include dizziness, light headedness, imbalance and disorientation but usually not 'true' or rotational vertigo. It is clearly tempting to hypothesize that patients with VV have a marked reliance on visual cues to orientation and are thus highly 'visually dependent'. Support for this view comes from findings showing that disorienting visual stimuli (tilted or rotating visual surroundings) have a stronger influence on verticality perception and postural stability in patients with VV than in patients with vestibular dysfunction but without VV [7, 16]. This may be a trait, acquired or enhanced perhaps as a consequence of compromised function in other sensory systems (e.g. vestibular), whereby perceptual preferences may develop and become inappropriate compensatory strategies for balance [32].

A question bearing on patient management and costing issues is how best to quantify VV in patients attending a vestibular rehabilitation service. Vestibular rehabilitation incorporating visuo-vestibular conflict and visual motion stimuli has been shown to provide significant long-term improvement for these symptoms in patients with chronic peripheral vestibular disorders [30]. More recently, virtual reality has been suggested as a useful tool for improving situation-specific VV symptoms such as those commonly provoked in supermarkets [37]. Therefore the therapist needs to be able to identify the patients who will require this additional component to treatment. At present, three widely available methods would be, *prima facie*, useful for measuring VV features. These are the Rod and Frame Test (RFT) [41], a classic test of visual control of orientation perception, computerized dynamic posturography (Equitest, Neurocom, Clackamas, OR, USA) a device available in many balance disorders units which assesses the ability to maintain upright balance in situations where vision can be sway referenced, and therefore becomes orientationally inaccurate, and the Situational Characteristics Questionnaire (SCQ), a symptom-based questionnaire which assesses features of the VV syndrome (revised version [16,24]). Studies in the literature have used one or more of these tests [16,23, 30] to assess VV, but the individual diagnostic value of each test and whether there is any correlation between the individual test results is not clear. This study addressed these particular questions. A group of patients with chronic vestibular disorder, both with and without VV, were studied with these three assessment tools.

The second purpose of the study was to assess the relationship between VV and emotional state in patients with chronic peripheral vestibular dysfunction. The relationship between psychological distress and vertiginous symptoms is well established [6,10,14–16] and a recent study showed that increased VV symptoms were significantly correlated with higher levels of anxiety and depression [30]. This study attempted to determine if anxiety and depressive symptoms were associated more with the types of symptoms (e.g. visual) experienced, their chronic state, or level of severity.

2. Materials and methods

2.1. Subjects

All patients were referred from the neuro-otology clinics at the National Hospital for Neurology and Neurosurgery, Queen Square, London, UK and Imperial College London, Charing Cross Hospital, London, UK after a complete neurological and neuro-otological examination including caloric testing, electronystagmography, Hallpike positional testing and pure tone audiograms. Thirty three patients were diagnosed as having a peripheral vestibular disorder on the basis of clinical history and/or neuro-otological findings and were separated into two groups. Group VV consisted of patients who in addition to a peripheral vestibular disorder (individual diagnoses reported below) reported, in response to open-ended questions (e.g. what makes your symptoms worse?), that their symptoms were provoked or exacerbated in certain visual environments with visual-vestibular conflict, or intense visual stimulation (e.g. supermarkets, motorways, crowds, striped or moving surfaces). The diagnoses were benign recurrent vertigo ($n = 1$), post-traumatic vestibulopathy ($n = 3$), vestibular nerve section for intractable vertigo ($n = 1$), Meniere's disease with intratympanic gentamicin injections ($n = 1$), benign paroxysmal positional vertigo (BPPV) with additional vestibular neuritis ($n = 1$), and idiopathic peripheral vestibular disorder, compatible with a history of vestibular neuritis ($n = 13$). Vestibular findings were directional preponderance ($n = 6$) and canal pareses ($n = 11$) (7 with additional directional preponderance, 1 due to vestibular nerve section). Group NVV (No Visual Vertigo) consisted of patients with a similar medical diagnosis but no VV. Individual diagnoses were benign recurrent vertigo ($n = 1$), benign paroxysmal positional vertigo (BPPV) with additional vestibular neuritis ($n = 3$), or idiopathic peripheral vestibular disorder, compatible with a history of past vestibular neuritis ($n = 9$), currently experienced dizziness and/or imbalance, but did not have VV. Vestibular findings were directional preponderance ($n = 3$) and canal pareses ($n = 8$) (6 with additional directional preponderance). Patients with BPPV were entered into the trial because of a persistent sense of imbalance or dizziness, after the resolution of the true vertigo of BPPV. The positional vertigo and nystagmus had been observed in the past but were not present for at least 6 months before entering the trial.

There were no significant age differences between Group NVV ($n = 13$; 9 females, 4 males; mean age 45.9 years, range 29–64 years) and Group VV ($n = 20$; 15 females, 5 males; mean age 39 years, range 22–67 years). No significant differences were found for symptom duration between patient populations; mean symptom duration for NVV patients was 5.3 years (range 7 months – 12 years) and for VV, 3.4 years (range 7 months – 17 years). Patients with evidence of CNS involvement, fluctuating symptoms (e.g. Meniere's disease, vestibular migraine) or other medical conditions in the acute phase (e.g. orthopedic injury) were excluded. Twenty age-matched normal subjects (Group NC; 11 females, 9 males; mean age 37.6 years, range 22–59 years) without a history of vestibular or other neurological pathology were included as controls. All experiments were approved by the local ethics committee and informed consent was obtained from all participants.

2.2. Dynamic Computerized Posturography

Dynamic Computerized Posturography: Sensory organization testing (Equitest; Neurocom International Inc., Clackamas, Oregon, USA) measures peak-to-peak anterior-posterior sway (displacement of centre of foot pressure). Testing is performed according to a published protocol under six different sensory conditions to assess the influence of visual, vestibular and somatosensory inputs on balance. In conditions 1 to 3 subjects stand on a stationary support surface with eyes open, eyes closed, and with sway-referenced vision, respectively. In conditions 4 to 6 a similar procedure is followed except the support surface is also sway-referenced. The program yields an average composite equilibrium score of all six conditions, ranging from 0 % (no balance) to 100% (maximum stability); scores below 70% are considered abnormal [11].

By normalizing each subject's performance on different sensory conditions to performance on condition 1, sensory preference ratios can also be computed. According to relevant experimental literature [16,31,35] and to the manufacturer's instructions [11], such ratios allow identification of poor use of or over-reliance on sensory cues for balance. Lower than average ratio scores indicate a poor use of somatosensory (2/1), visual (4/1), or vestibular cues (5/1 and 6/1) for balance, respectively; while for ratio 3/1, they show an over-reliance on visual information even when it is inappropriate.

Ratios were compared to normative data provided by Neurocom International [11].

2.3. Rod and Frame Test

A chin rest secured the subject's head in place while he/she was seated upright at a distance of 80 cm from the test apparatus consisting of a 40×0.5 cm rod placed co-axially within a 90×90 cm frame (width: 2.4 cm). The test apparatus was adjusted so the centre of the rod was at eye level. Experiments were conducted in darkness with the only visible objects being the fluorescent rod and frame. The angular position of the rod could be controlled by both the subject and the experimenter with separate hand-held potentiometers, but the frame only by the latter.

All subjects completed ten trials for each of three test conditions (complete darkness without frame and with the frame tilted at 28° clockwise and counter clockwise). Prior to each trial the rod was tilted $\sim$40° clockwise or counter clockwise in counterbalanced order and this was randomized between subjects. Subjects were asked to adjust the rod to their perceived gravitational vertical without time constraints. Total test duration was approximately 15 minutes. Subjective visual vertical (SVV) values were recorded online using in-house software [Mr. D. Buckwell, Medical Research Council, London, UK] and were taken as the angular deviations from true gravitational vertical (0°) measured in degrees. Tilt of the top of the rod to the right of the subject (clockwise) was indicated as a positive value and a tilt towards the subject's left (counter clockwise) negative. For each subject, the average SVV value during otherwise complete darkness was used as a baseline for SVV values obtained with frame tilt.

Sitting upright in a dark room, healthy individuals are able to set a luminescent rod to within a mean deviation of $\pm 2^\circ$ of the true gravitational vertical [3, 13,36] while with the frame tilted the subjective visual vertical shows a mean deviation of $\pm 4^\circ$ [16,17].

2.4. Questionnaires Assessing Symptoms and Emotional State

All participants completed a set of validated questionnaires in order to assess symptoms, the situations that provoke them and emotional status. Questionnaires were to be completed relative to symptoms experienced during the previous month and took approximately 15 minutes to complete.

A. The Situational Characteristics questionnaire (SCQ) ([16], adapted from 24; copy in Appendix 1) consisted of nineteen questions, yielded a normalized score between 0 (never) to 4 (always) and measured how frequently symptoms were provoked or exacerbated in environments with visual-vestibular conflict or intense visual motion (e.g. supermarket aisles, watching moving scenes on the television, looking at a scrolling computer screen, traveling on escalators). The normalized score was obtained by dividing the total sum (possible range 0–76) by the total number of activities experienced.

B. The Vertigo Symptom Scale (VSS) [43] consisted of four sub-scales measuring symptoms of a) vertigo (e.g. dizziness, giddiness, and/or spinning); b) imbalance (e.g. a feeling of imbalance so severe that you actually fall); c) autonomic symptoms (e.g. heart pounding or fluttering); and d) somatization (e.g. a heavy feeling in the arms or legs). The normalized score for each sub-scale was calculated by dividing the total sum by the number of questions. The first two and last two sub-scales were combined to yield two normalized scores, ranging from 0 (no symptoms) to 4 (daily symptoms), for assessing the frequency of general, non-visually induced vertigo and imbalance (VSS-V) and autonomic/somatic anxiety (VSS-A).

C. The Hospital Anxiety and Depression Scale (HAD) [44] independently assessed non-somatic symptoms of anxiety (HAD-A) and depression (HAD-D). Composite scores for each sub-scale ranged between 0 and 21. Scores between 8-10 are considered borderline values and those above 10 indicate clinical depression or anxiety.

2.5. Analysis

All statistical analyses were performed using the SPSS software package (SPSS Inc., Chicago, USA). All data are presented as mean $\pm$ SD. Significance levels are set at $p \leqslant 0.01$, as opposed to the commonly used $p < 0.05$, in order to increase the confidence and accuracy of the statistic and reduce the possibility of Type I error. MANOVA (multi-way analysis of variance) was used to analyze questionnaire and demographic data (age, symptom duration); when significant differences were indicated, Bonferroni *post-hoc* tests were conducted. As non-parametric correlation analysis (Spearman's correlation coefficient) noted significant correlations between age and posturography ($r = -0.33$, $p = 0.02$) as well with RFT ($r = 0.43$, $p = 0.001$) data, MANCOVA (multi-way analysis of covariance) was performed with age as a covariable for these two tests. The non-parametric Spearman's correlation coefficient was also used to assess whether a) a relationship existed between subjective (e.g. SCQ) and objective tests (e.g. posturography, RFT) of VV and b) psychological symptoms were correlated with posturography, RFT performance, and symptom duration, severity or type. Values outside the mean $\pm$ 2 SD of test scores for the normal control group were considered abnormal.

3. Results

3.1. Dynamic Computerized Posturography

With age as a covariable, significant differences were noted between subject groups for composite posturography scores ($F_{(2,49)} = 12.36,\ p < 0.01$; Fig. 1) and average values for ratios 3/1 ($F_{(2,49)} = 4.66,\ p = 0.01$), 4/1 ($F_{(2,49)} = 9.87,\ p < 0.01$), 5/1 ($F_{(2,49)} = 6.36,\ p < 0.01$) and 6/1 ($F_{(2,49)} = 11.00,\ p < 0.01$). Descriptive data and statistics are displayed in Table 1. Post-hoc analysis revealed ratio 6/1 scores for both patient groups were significantly below those of normal controls ($p < 0.01$). For composite scores and ratio values 3/1, 4/1, and 5/1 only Group VV scores differed significantly from normal controls ($p < 0.01$; Table 1; Fig. 1).

Only 54% ($n = 7$) of patients in Group NVV and 50% ($n = 10$) in Group VV scored outside normal ranges (70%–100%) for posturography composite scores. Percentages for ratio values are only reported for cases where significant differences were noted be-

Table 1
Mean (SD) scores for posturography. Both average composite equilibrium scores and ratios are shown separately for each group

Posturography Score:	NC ($n = 20$)	NVV ($n = 13$)	VV ($n = 20$)
Composite (%)	80.70 (6.07)	68.92 (7.19)	64.50 (14.81)*
Ratios			
2/1	0.98 (0.02)	0.98 (0.03)	0.94 (0.10)
3/1	0.98 (0.02)	0.95 (0.05)	0.93 (0.06)*
4/1	0.88 (0.07)	0.81 (0.08)	0.69 (0.21)*
5/1	0.72 (0.11)	0.59 (0.12)	0.51 (0.27)*
6/1	0.73 (0.11)	0.40 (0.23)*	0.44 (0.28)*

*($p \leqslant 0.01$) indicates a significant difference compared to Group NC.

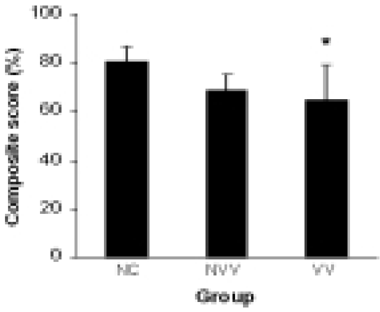

Fig. 1. Comparison of composite equilibrium posturography scores (mean and SD) for all three groups: Normal controls (Group NC), and patients with vestibular pathology plus (Group VV) or minus (Group NVV) visual vertigo. The (*) denotes a statistically significant difference between Groups NC and VV.

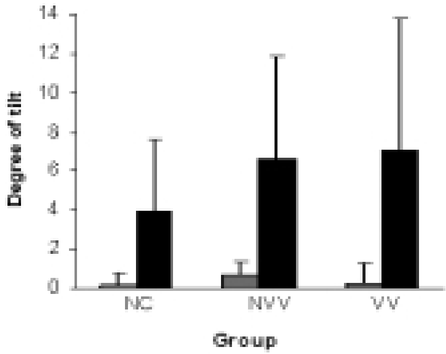

Fig. 2. Mean and SD for Rod and Frame test scores in darkness (grey bar) and with the frame tilted (black bar) for all groups. No statistical significances were noted between any of the groups.

tween normal controls and a patient group. Sixty-two percent of Group NVV ($n = 8$) and 55% ($n = 11$) of Group VV scored outside normal ranges for ratio 6/1. In Group VV, 45% ($n = 9$) of patients had abnormal scores for ratio 3/1, and 40% (n=8) for both ratios 4/1 and 5/1.

3.2. Rod and Frame Test

Since no differences were noted between average SVV settings for clockwise and counter clockwise frame tilts, results were normalized by reversing the polarity of values obtained during counter clockwise frame tilts. MANCOVA revealed no significant differences between groups for SVV tilt settings either in darkness or with the frame tilted (Fig. 2). SVV settings for all groups were close to gravitational vertical in darkness, and were deviated in the direction of frame tilt with the frame tilted. Although average SVV tilt deviations were smaller for normal controls compared to the two patient populations whose SVV tilt scores were similar, individual SVV tilt averages for normal controls were highly variable ranging from 0.54° to 15.52° with the frame tilted. Thus, only 15% of patients in both groups (Group NVV $n = 2$; Group VV $n = 3$) scored outside the mean ± 2 SD for normal controls.

3.3. Questionnaires

Significant differences were noted between groups for all questionnaires (*SCQ*: $F_{(2,50)} = 83.29, p < 0.01$; *VSS-V*: $F_{(2,50)} = 18.78$, $p < 0.01$; *VSS-A*: $F_{(2,50)} = 21.13$, $p < 0.01$; *HAD-A*: $F_{(2,50)} = 9.96$, $p < 0.01$; *HAD-D*: $F_{(2,50)} = 11.65$, $p < 0.01$). Descriptive data and statistics are displayed in Table 2. Post-hoc analysis revealed that autonomic/somatic anxiety symptom scores (VSS-A) were significantly higher than normal controls for both patient groups (*NVV*: $p < 0.01$; *VV*: $p < 0.01$) between whom no significant differences were noted. For anxiety (HAD-A) and depression (HAD-D) scores, significant differences were found only between Groups VV and NC ($p < 0.01$). Average visual (SCQ) (Fig. 3) and general, non-visually induced vertigo and imbalance scores (VSS-V) were significantly higher for Group VV compared to both normal controls ($p < 0.01$) and Group NVV ($p < 0.01$), where average scores tended to be higher than in normal con-

Table 2
Comparison of questionnaire scores (mean and SD) for all groups

	NC ($n = 20$)	NVV ($n = 13$)	VV ($n = 20$)
SCQ	0.16 (0.28)	0.40 (0.27)	2.05 (0.72)*
VSS-V	0.03 (0.08)	0.18 (0.21)	0.89 (0.73)*
VSS-A	0.24 (0.30)	0.80 (0.47)*	1.18 (0.57)*
HAD-A	4.40 (3.76)	7.5 (4.40)	9.9 (3.9)*
HAD-D	2.30 (2.50)	4.7 (3.52)	7.9 (4.71)*

SCQ = Situational Characteristics Questionnaire; VSS-V = Vertigo Symptom Scale (general vertigo and imbalance symptoms); VSS-A = Vertigo Symptom Scale (autonomic somatic anxiety symptoms); HAD-A = Hospital Anxiety and Depression Scale- anxiety component; HAD-D = depression component. Symbols indicate a significant difference compared to Group NC (*) or between patient groups (·) respectively ($p < 0.01$).

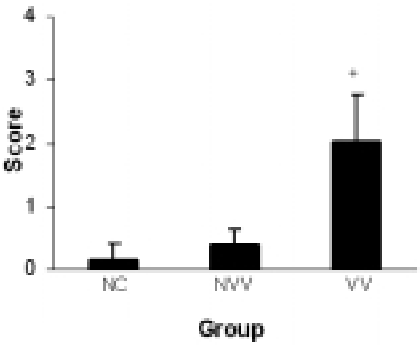

Fig. 3. Mean and SD of Situational Characteristic Questionnaire scores for all groups. The (+) indicates significant differences between Group VV and both Groups NC and NVV.

trols, but no significant differences were noted. Concerning the SCQ, 100% of Group VV patients scored outside normal ranges, while all values for patients in Group NVV were within normal ranges.

3.4. Correlations

Only significant correlations are reported below. In Group NC, significant correlations were noted between the RFT with the frame tilted and ratio 6/1 on posturography ($r = -0.57$, $p < 0.01$). When pooling both patient groups together, no correlations were found between the SCQ, the RFT or posturography composite and ratio values. In addition, it was important to assess whether psychological symptoms (autonomic/somatic anxiety: VSS-A; anxiety: HAD-A, depression: HAD-D) were associated with duration and severity of subjective general vertigo and imbalance (VSS-V) and VV (SCQ) symptoms, posturography, and RFT values. Only increased HAD-D scores significantly correlated with increased SCQ values ($r = 0.46$, $p < 0.01$).

4. Discussion

The present study investigated how effectively visually-induced symptoms in vestibular patients could be assessed with commonly available tests, if subjective symptoms of visual sensitivity correlated with findings on perceptual and visual-postural tests, and the relationship between emotional state and symptoms. The topic has important clinical implications since VV is considered to be a troublesome [7,16] but treatable [30] syndrome in patients with vestibular disorders. The main findings of this study will be discussed in detail below.

Questionnaire scores on the SCQ were significantly worse for patients with VV compared to both Groups NVV and NC. Patients with VV were also significantly different from normal controls on posturography across most measures as indicated in Table 1. In contrast, Group NVV was only significantly different to the normal control group on posturography ratio 6/1 a finding that has been interpreted as impaired use of vestibular signals in balance control [2]. Both patient groups behaved similarly on RFT and, although SVV tilt was greater on average compared to normal control subjects no significant differences were noted.

No correlations were found between the SCQ, the RFT which assesses visual control of orientation perception, and posturography measures of visual-postural dysfunction (ratios 3/1 and 4/1). The only significant correlation between the RFT and posturography was for the normal control group where subjects who had the greatest tilt of the line in the RFT had the lowest 6/1 ratio for posturography. These findings indicate a perceptual-postural correlation of visual dependency and are in agreement with those from previous studies which have assessed the RFT and postural control in normal control subjects [19,21]. Furthermore no correlation was found between anxiety scores, general vertigo and imbalance, and VV symptoms while depression scores directly related to the severity of VV symptoms.

4.1. Quantitative assessment of visual vertigo symptoms

4.1.1. Dynamic computerized posturography

Composite posturography scores were significantly different between normal control subjects and patients with VV. Despite this, approximately 50% of individuals in both patient groups had normal scores. In recent years, there have been conflicting results concerning posturography's sensitivity in detecting balance difficulties (composite score below 70%) with previous reports of a 50% chance for detecting balance impairments in patients with vestibular disorders [8]. It is possible that the equipment's lack of sensitivity may be due to the nature of the visual stimulus. The sway-referenced visual surround in Condition 3 was specifically designed to provide inaccurate visual cues about the position of the body in space. The sway-referenced surround follows a person's center of gravity sway and thus, when sway is small, the movement of the surround may be insufficient to produce an abnormal reaction. This may mean that intense visual motion may be required to identify the majority of patients with VV, as in the study of Guerraz et al. [16] with a roll plane rotating disk (see below). In its current state posturography can be incorporated as part of a comprehensive assessment but, in isolation (e.g. see Table 1), it is not capable of separating patients with VV symptoms and those without.

4.1.2. Rod and frame test

Surprisingly, the RFT, which is accepted as the 'classic' test of visual dependency [19] fails to distinguish normal control subjects from chronic vestibular patients, including those with VV and high SCQ scores. Many sensory cues, otoliths, retinal orientation, haptic cues, and visual context contribute to assessment of vertical orientation in the RFT. A given perceptual estimate is a combination of all these cues [12,18] so it may not be surprising that an impairment in one sensory channel remains undetected when surveying a small population. Only in subjects with a strong preferential use of visual field cues can substantial RFT effects be seen, as in extreme normal subjects [20,21,26]. It appears that vestibular dysfunction does not force such extreme reliance on visual field effects for *static* RFT estimates, even in patients who profess to be disturbed by disorienting visual environments. This may be one reason why no correlations were found between the SCQ and the RFT as the SCQ concentrates on symptoms provoked primarily by dynamic situations (e.g. whilst walking down a supermarket aisle).

The rod and disk test however, as mentioned above for rotating disk posturography, may be more effective in identifying visual dependency for *dynamic* situations. Indeed, Guerraz et al. [16] showed that SVV deviations during disc rotation were double those with a static frame tilt. Furthermore, differences between normal control subjects and patients with VV displayed greater significance suggesting dynamic disk rotation may be a more effective assessment tool. The rod and disk test was not included as part of the assessment protocol in this study because at the present time it has only been used for research purposes rather than as a routine, clinically available test.

4.1.3. Situational characteristics questionnaire

General non-visually induced vertigo and imbalance as well as VV symptoms were found to be significantly higher in Group VV compared to both Groups NC and NVV. Of these two subjective scales, only the SCQ specifically addresses VV symptoms. The SCQ made a statistically significant distinction between types of patient as shown by average scores for Groups VV and NVV (Fig. 3 and Table 2). This finding may not be surprising since it is the patient's report of experiencing increased symptoms in situations such as those included in the SCQ that determine the diagnosis of VV by the clinician. However, the study aimed to investigate if the currently available clinical tools to assess VV would corroborate the clinical diagnosis and quantify the severity of the symptoms. The findings indicate that the shortened version of the SCQ [16] used in this study which is cost efficient and can be completed within a short period of time, effectively fulfills these aims. In particular, quantification of the patient's VV symptoms is a crucial point during rehabilitation where the SCQ can be used pre- and post- treatment to determine the level of improvement [30].

The SCQ, however, cannot assess whether a patient's postural behavior or orientation estimates are disturbed by visual environments. Jacob et al. [23] showed no correlation between the SCQ and posturography findings in patients with agoraphobia. Interestingly, although patients in both the Jacob et al. [23] work and in Group VV in this study had high SCQ scores, their posturography patterns were different. In the Jacob et al. [23] study, patients were found to have a surface-dependence, or in other words be overly reliant on surface cues for balance (abnormal scores on conditions 4, 5, and 6 of posturography). In the current study, patients showed a possible sensory re-weighting problem with abnormal scores on conditions 3, 4, 5 and 6 whereby condition 3 indicates an inability to "ignore" disturbing visual stimuli and conditions 4, 5, 6 are dominated by the proprioceptive stimulus.

The findings from this study showed that there was no correlation between any of the three tools assessing visual sensitivity. This could be because the objective tests (RFT and posturography) were not able to detect VV in their present state and that more dynamic visual stimuli are needed to differentiate between VV and

NVV patient groups as stated above. However, this will not be known until further studies can be conducted with more intense visual stimuli being used for the objective tests and correlations can be re-assessed.

4.2. The relationship between psychological distress and symptoms

Anxiety can either be a pre-morbid condition or can occur secondary to the vestibular disorder [22,27, 34]. The presence of increased anxiety in patients with vestibular disorders has been shown [15,42], but it is not known how anxiety is associated with specific types of symptoms (e.g. visual or general vertigo and imbalance) and symptom duration. In the current study, no significant differences were noted between the two patient groups but depression and anxiety levels were significantly different between Groups NC and VV. Furthermore, anxiety and autonomic results were not correlated with the type, severity, or duration of symptoms.

In clinical practice it is important to differentiate between patients with psychogenic chronic subjective dizziness and patients with VV due to a vestibular disorder as both groups complain of intolerance to complex visual environments (e.g. crowds, busy restaurants), difficulty performing visually demanding activities such as reading [33] but rarely 'true' vertigo. Various studies have shown that patients with psychogenic conditions (e.g. phobic postural vertigo, agoraphobia) who present with imbalance and non-specific dizziness perform differently during objective balance testing. Patients with phobic postural vertigo exhibit less postural sway the more difficult the balance task [28] and agoraphobics use a surface-dependent strategy [23]. In contrast, patients with VV in the current study displayed a sensory re-weighting problem and increased instability with greater task complexity. Furthermore, the results of the current study suggest that patients with vestibular disorders experience similar levels of anxiety and autonomic symptoms irrespective of the presence or absence of VV symptoms. These findings support the limited evidence available suggesting that the VV syndrome in patients with a vestibular disorder is not of psychogenic origin [16,30].

Results from this study were in accordance with those from Grunfeld et al. [15] which noted no significant relationship between symptom duration and depression scores. Depression scores, however, significantly correlated with severity of VV symptoms and this can be interpreted as the depression being secondary to the vestibular impairment [34]. It is therefore logical to expect that depression levels directly relate to symptomatic improvement, and therefore, return to normal ranges following vestibular rehabilitation, unlike anxiety scores which although improved remain within borderline ranges [30].

5. Conclusion

A clinician's diagnosis of VV can be quickly corroborated with a simple questionnaire which can also be used to indicate the severity of VV symptoms. The presence of VV does not necessarily imply visual dependency, as measured with the conventional (static) RFT, nor visuo-postural dysfunction, as measured with dynamic posturography. Separation of these patients by means of objective psychophysical or postural measures may require stronger dynamic visual stimuli (e.g. rotating disks as used in previous studies). Anxiety is common in patients with vestibular disorders irrespective of symptom type, severity, and duration whereas depression is directly associated with symptom type (VV) and severity. Visual vertigo symptoms, associated balance and perceptual orientation impairments, as well as emotional state must be separately evaluated in all patients with vestibular disorders in order to help organize the most appropriate physical therapy intervention.

Acknowledgements

We would like to gratefully acknowledge financial support for Dr. M. Pavlou from the Dix foundation. We would also like to thank Professor Michael A. Gresty for his valuable comments.

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