Is there a hypersensitive visual alarm system in panic disorder?

Daniela Caldirola a,⁎, Roberto Teggi b, Stefano Bondi b, Fabiana Leao Lopes c, Massimiliano Grassi a, Mario Bussi b, Giampaolo Perna a,d

a Department of Clinical Neuroscience, San Benedetto Hospital, Hermanas Hospitalarias, Albese con Cassano, Italy
b Department of Otolaryngology, Vita-Salute University, San Raffaele Hospital, Milan, Italy
c Anxiety Disorder Clinical and Research Unit, Vita-Salute University, San Raffaele Hospital, Milan, Italy
d Department of Psychiatry and Neuropsychology, Faculty of Health, Medicine and Life Sciences, University of Maastricht (NL), The Netherlands

Abstract

Agoraphobia in Panic Disorder (PD) has been related to abnormal balance system function. Vision influences balance and behavioural adaptations; peripheral vision influences orienting and fast defensive reactions whereas central vision analyses details of objects. We have hypothesized that the abnormal balance function in PD could be mainly related to peripheral vision as part of a defensive alarm system in the brain. In 25 patients with PD and agoraphobia and 31 healthy controls we assessed, by posturography, balance system reactivity to video-films projected in peripheral and central visual fields (randomized sequence). Length, Velocity and Surface of body sway were calculated. Patients increased their body sway during peripheral stimulation, whereas controls did not; the two groups showed a similar increase of body sway during central stimulation. Anxiety levels during peripheral stimulation significantly influenced the postural response in the group of patients. These preliminary results suggest that the higher visual sensitivity to peripheral stimulation in patients with PD and agoraphobia may be linked to a more active “visual alarm system” involving visual, vestibular and limbic areas that might influence the development of agoraphobia in situations where environmental stimuli are uncertain.

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1. Introduction

Hypersensitive alarm systems have been postulated in Panic Disorder (PD). Klein’s suffocation false alarm theory postulates that panic attacks occur when a suffocation alarm system is erroneously triggered (Klein, 1993); Gorman’s neuroanatomical model postulates panic attacks as conditioned fear responses mediated by an overly sensitive fear network (Gorman et al., 2000); the three-alarms (true, false, learned) theory postulates panic attacks as the results of both spontaneous firing of fear system and conditioning processes to internal or external cues (Bouton et al., 2001). Although these theories do not completely overlap, they share the idea that hypersensitivity in alarm systems triggered by stimuli plays a key role in pathogenesis of PD and related phobic conditions.

 Patients with PD and agoraphobia often show a high sensitivity to complex sensorial environments (shopping malls, traffic, crowds) where they experience dizziness and discomfort (Jacob et al., 1993; Asmundson et al., 1998). Most studies showed that these patients do not have specific vestibular diseases but have subclinical abnormalities of balance system and their balance control rely mainly on non-vestibular cues, proprioceptive or mostly visual (visual dependence) (Jacob et al., 1995, 1997; Asmundson et al., 1998; Perna et al., 2001; Staab, 2006).

Overall, vision provides important information for balance adaptations and behavioural responses to surrounding stimuli; visual information from central and peripheral visual fields have complementary roles with specific functions and might have different influence on postural control (Berensci et al., 2005). Keeping in mind that there are partial overlap and significant cross-talk among the areas comprising the two visual streams, preferred pathways have been proposed. Central vision involves mainly parvocellular cells and the ventral stream visual areas (V1-V2-V4, inferior occipital-temporal cortex) and analyses details of objects near the focus of attention (Kandell, 1991; Stephen et al., 2002; Palmer and Rosa, 2006). Peripheral vision involves mainly magnocellular retinal cells, lateral geniculate nucleus and the dorsal stream visual areas (occipital -V1-V2-V3-V5/MT- and parietal cortices); this is a fast pathway, with shorter latency and more sustained activation than the central vision pathway, and has connections with areas of limbic cortex; thus, peripheral vision scans surroundings for changing conditions and is involved in fast orienting and postural adaptations and in defensive reactions to potentially dangerous stimuli.

On this bases, we hypothesized that the patients with PD who develop agoraphobia might be hypersensitive to the influence on...
balance of moving visual stimuli, resembling every day-life environment, localized in the peripheral visual field.

2. Methods

2.1. Subjects

Twenty-five outpatients with PD and agoraphobia and 31 healthy subjects were included. Patients were recruited among those consecutively referred to the Anxiety Disorders Clinic and Research Unit of San Raffaele Turro Hospital in Milan, over a year. Healthy controls (free of lifetime psychiatric disorders) were recruited by advertisements placed around the University.

All subjects underwent the MINI International Neuropsychiatric Interview for DSM-IV-Plus (Sheehan et al., 1994), neuro-otological examination and medical history collection (Day 1, 7 ± 2 days after recruitment). Exclusion criteria were: lifetime history of psychiatric disorders, chemotherapy, lifetime neurological and orthopaedic diseases, migraine, polyneuropathies; lifetime diagnoses of vestibular disorders or episodes of rotational vertigo with nausea; pregnancy; concurrent psychiatric disorders for patients with PD.

The clinical symptomatology was quantified by the Panic Associated Symptoms Scale (PASS) (Arcy et al., 1991). All subjects were assessed by the State-Trait Anxiety Inventory for trait anxiety (STAI-II) (Spiegelberg et al., 1970), the 25-item Dizziness Handicap Inventory scale (DHI, total score, range 0-100), evaluating the self-perceived handicap associated with dizziness (Jacobson and Newman, 1990) and the Visual Analogue Scales for Dizziness (VAS-D) describing, on a continuum from 0 (no dizziness) to 100 (the worst dizziness imaginable), the severity of dizziness in their everyday life over the two months before recruitment.

Patients were free of psychotropic medications for at least 2 weeks before posturography; all subjects had to refrain from alcohol and any kind of medication for at least 2 days, sainthines for at least 8 hours and food or smoking for at least 2 hours before posturography (Gagey and Weber, 1999). Posturography was performed within two days after the clinical examination (Day 2).

This study was in accordance with the Declaration of Helsinki and approved by the Ethical Committee ASL “City of Milan”; all participants provided their written informed consents after the procedure had been fully explained.

2.2. Procedure

Each subject underwent posturography in two different conditions: 1) with visual stimulation in peripheral visual field and 2) with visual stimulation in central visual field. The two testing conditions were carried out in a randomized sequence according to a computer generated list. After each posturography the subjects had a five minutes rest break. The subjects were told that posturography is a safe test assessing the individual strategy in maintaining posture in different conditions, that they should act on the instructions given by the examiner and could stop the session whenever they wanted. We did not mention moving visual stimuli in order to minimize the influence of expectation and high level readjustment processes on postural responses (Guerraz et al., 2001).

2.3. Posturography

Posturography gives information on the ability to integrate multiple inputs in the control of posture (Gagey, 1991). We used a force platform (Amplaid SveP, 10 Hz-signal acquisition), conforming to the standards of the International Society of Posturology (Blizzi et al., 1985). Vertical force transducers recorded changes in successive positions of the Centre-of-Pressure (COP), obtaining the total sway path of the COP. Posturography was carried out by otolaryngologists blind to the diagnosis of the subjects, according to a standardized procedure (Gagey and Weber, 1999), in a quiet room between 4 p.m. and 6 p.m.

These variables were evaluated (Gagey and Weber, 1999; Yasuda et al., 1999; Gagey, 1991):

- Length of body sway (millimetres) that is the sum of the distances between the sequential sampled positions of COP. Length is considered the main posturographic variable.
- Velocity of body sway (millimetres / seconds), that represents the energy spent by the system in maintaining posture.
- Surface of the body sway (millimetres²), that is the confidence ellipse containing 90% of the sampled positions of the COP and indicates the precision of the postural system.

Each posturography with visual stimulation comprised three sequential conditions:


The recording in each condition took 30 seconds. During the Open-Eyes conditions, the subjects stared at a white vertical line (20 centimeters long by 4 centimeters wide) on a black background projected on a 17-in. display in front of them. Visual stimulation in peripheral visual field was produced by a video-film (32 times-accelerated), showing people moving in various contexts, projected on a lateral (right side) 150 cm square screen, forming a 30°-angle with the line connected the head of the subjects and the central display and covering an angle from 10° to 50° of the visual field. The subjects were instructed to stare at a white vertical line on a black background projected on the display in front of them, without moving head and gaze during the whole visual stimulation.

Visual stimulation in central visual field was produced by a video-film showing moving images of a tree in a square with buildings, resembling an optokinetic stimulus with slow phase velocity of 30°/second without any spatially fixed reference points (Jacob et al., 1995); moving images were projected on the display in front of the subjects, adjusted in height to eye level, at a distance of 130 cm, covering a visual field of 12°. The subjects were instructed to stare at the display without moving head and gaze during the whole visual stimulation.

The moving scenes were selected in order to resemble everyday life contexts not related to agoraphobic situations. The room was in dim illumination during the visual stimulations and in full-light during all the other conditions.

Visual Analogue Scales for Anxiety (VAS-A) and Dizziness (VAS-D) (continuum from 0, no anxiety / dizziness, to 100, the worst anxiety / dizziness imaginable) were administered immediately before and after posturography; the VAS-D were referred to the visual stimulation and to the moment the immediately after posturography.

2.4. Statistical analyses

Continuously distributed variables are described as mean and standard deviation (SD) (standard deviations are reported in parentheses); the significance of any difference between groups was evaluated by T-test for independent samples and analysis of variance (ANOVA) for repeated measures. Post-hoc comparisons were performed using the Tukey HSD test. Since anxiety and dizziness measures and posturographic variables showed standard deviations proportional to the means, a logarithmic transformation was applied to the data in order to meet requirements for performing ANOVA. When ANOVA for repeated measures was performed with covariates, we performed pairwise comparisons between adjusted means for covariate effects, applying Sidak p-value correction, since the post-hoc tests on observed means do not take in account the confounding factors related to the use of the covariates in the model. Nominal data were compared by Chi-Square Test.

3. Results

Table 1 reports demographic and clinical features of patients with PD and agoraphobia and controls. Patients with PD and agoraphobia showed higher STAI-Trait, Dizziness Handicap Inventory and VAS-D scores than controls.

3.1. Anxiety and dizziness during posturography

3.1.1. Anxiety and dizziness during visual stimulation in peripheral visual field

Mean VAS-A scores before, during and after peripheral stimulation in patients with PD and agoraphobia were reported in Table 2. ANOVA

Table 1

| Demographic and clinical features of the two groups. |
|---------------------------------------------|-----------------|-----------------|-----------------|
| Patients with PD and Agoraphobia (n=25) | Healthy subjects (n=31) | t     | p      |
| Age (years) | 34.9 (11.3) | 32.0 (10.4) | 0.99 | 0.32   |
| Female | 17 (68%) | 15 (48.4%) | - | -      |
| BMI (kg/m²) | 22.7 (3.9) | 22.0 (2.9) | 0.73 | 0.46   |
| Sport activity | - | - | - | -      |
| Subjects | 7 (28%) | 15 (48.8%) | - | -      |
| Hours/weeks | 2.8 (1.3) | 2.9 (1.8) | 0.09 | 0.92   |
| STAI-II | 48.1 (11.1) | 36.1 (8.0) | 4.62 | <0.001 |
| DHI | 26.6 (20.1) | 3.8 (7.8) | 5.19 | <0.001 |
| VAS-D | 38.1 (31.6) | 18.4 (5.4) | 5.65 | <0.001 |
| Age of onset of PD (years) | 27.9 (9.6) | - | - | -      |
| Illness duration (years) | 8.5 (11.3) | - | - | -      |
| STAI-III | - | - | - | -      |
| Total score | 5.3 (1.8) | - | - | -      |
| Panic attacks | 1.6 (1.6) | - | - | -      |
| Anticipatory anxiety | 2.1 (0.6) | - | - | -      |
| Agoraphobia | 1.4 (0.6) | - | - | -      |

Values are expressed as mean (SD) or number of subjects (%).
BM = Body Mass Index; Age = Agoraphobia; * Subjects practising sports for at least 6 months before recruitment.
STAI-II = State-Trait Anxiety Inventory-Trait; DHI = Dizziness Handicap Inventory; PASS = Panic Attack Scale.
VAS-D = Visual Analogue Scale for Dizziness.
† Significance of difference between by the T-test for independent sample or Chi-Square Test.
Statistics are presented in the text. L = Length, V = Velocity, S = Surface; PRE = before, IN = during, POST = after visual stimulation.

Values are expressed as mean (SD). ANOVA for repeated measures showed higher scores in patients than controls, effect of Diagnosis (F = 17.64, df = 1, 54, p < 0.001).

Mean VAS-D scores before, during and after peripheral stimulation in patients with PD and agoraphobia were reported in Table 2. ANOVA for repeated measures showed higher scores in patients than controls, effect of Diagnosis (F = 16.46, df = 1, 54, p < 0.001), and effect of Time (F = 11.86, df = 2, 108, p < 0.001). Post-hoc analyses for Time showed higher VAS-D scores during stimulation with respect to before (p < 0.001) and lower VAS-D scores after stimulation than during (p < 0.01). No other significant post-hoc comparisons were found.

### 3.1.2. Anxiety and dizziness during visual stimulation in central visual field

Mean VAS-A scores before, during and after central stimulation in patients with PD and agoraphobia were reported in Table 2. ANOVA for repeated measures showed higher scores in patients than controls, effect of Diagnosis (F = 17.64, df = 1, 54, p < 0.001), and an effect of Time (F = 5.72, df = 2, 108, p < 0.001). Post-hoc analyses for Time showed higher VAS-A scores during central stimulation with respect to before (p < 0.001) and lower VAS-D scores after stimulation than during (p < 0.01). No other significant post-hoc comparisons were found.

Mean VAS-D scores before, during and after central stimulation in patients with PD and agoraphobia were reported in Table 2. ANOVA for repeated measures showed higher scores in patients than controls, effect of Diagnosis (F = 15.83, df = 1, 54, p < 0.001), and an effect of Time (F = 12.79, df = 2, 108, p < 0.001). Post-hoc analyses for Time showed higher VAS-D during central stimulation than before (p < 0.001) and lower VAS-D after stimulation than during (p < 0.001). No other significant post-hoc comparisons were found.

### 3.2. Posturographic variables

#### 3.2.1. Posturographic variables during visual stimulation in peripheral visual field

Table 2 reports the values of posturographic variables before, during and after peripheral stimulation. Fig. 1 shows the course of Length during posturography with peripheral stimulation as representative of postural response in this condition.

ANOVA for repeated measures showed, for Length, higher values in patients than controls, effect of Diagnosis (F = 9.37, df = 1, 54, p < 0.01), and effects of Time (F = 27.04, df = 2, 108, p < 0.001) and Time x Diagnosis interaction (F = 6.04, df = 2, 108, p < 0.01); post-hoc analyses for Time showed higher Length during stimulation than before (p < 0.001) and lower Length after stimulation than during (p < 0.001); post-hoc analyses for Time x Diagnosis showed, in the group of patients, higher Length during peripheral stimulation than before (p < 0.001) and lower Length after stimulation than during (p < 0.001); in controls, lower Length after stimulation than during (p < 0.01). No other significant post-hoc comparisons were found.

ANOVA for repeated measures showed, for Velocity, higher values in patients than controls, effect of Diagnosis (F = 28.22, df = 1, 54, p < 0.001), and effects of Time (F = 4.92, df = 2, 108, p < 0.01) and Time x Diagnosis interaction (F = 20.27, df = 2, 108, p < 0.001); post-hoc analyses for Time showed lower Velocity after stimulation than both before (p < 0.05) and during (p < 0.01); post-hoc analyses for Time x Diagnosis showed higher Velocity after peripheral stimulation in patients than controls (p < 0.001) and lower Velocity after stimulation than both before (p < 0.001) and during (p < 0.001) stimulation in controls. No other significant post-hoc comparisons were found.

ANOVA for repeated measures showed, for Surface, an effect of Time x Diagnosis interaction (F = 4.8, df = 2, 108, p < 0.01); post-hoc analyses showed, in patients, higher Surface during peripheral stimulation than before (p < 0.05) and lower Surface after stimulation than during (p < 0.05). No other significant post-hoc comparisons were found.

### Fig. 1

Length during peripheral stimulation. PRE = before, IN = during, POST = after peripheral stimulation. Statistics are presented in the text. Length is expressed in millimetres. Means in the graph refer to data after logarithmic transformation.

Table 2 reports the values of posturographic variables before, during and after visual stimulation. Lenght is expressed in millimetres. Means in the graph refer to data after logarithmic transformation.
3.2.2. Posturographic variables during visual stimulation in central visual field

Table 2 reports the values of posturographic variables before, during and after central stimulation. Fig. 2 shows the course of Length during posturography with central stimulation as representative of postural response in this condition.

ANOVA for repeated measures showed, for Length, an effect of Time (F=93.93, df=2, 106, p<0.001); post-hoc analyses for Time showed higher Length during stimulation than before (p<0.001) and lower Length after stimulation than both during (p<0.001) and before (0.001). No other significant post-hoc comparisons were found.

ANOVA for repeated measures showed, for Velocity, an effect of Time (F = 18.49, df=2,106, p<0.0001); post-hoc analyses for Time showed higher Velocity during stimulation than before (p<0.001) and lower Velocity after stimulation than both during (p<0.001) and before (p<0.001). No other significant post-hoc comparisons were found.

ANOVA for repeated measures showed, for Surface, an effect of Time (F = 49.69, df=2,106, p<0.0001); post-hoc analyses for Time showed higher Surface during stimulation than before (p<0.001) and lower Surface after stimulation than both during (p<0.001) and before (p<0.001). No other significant post-hoc comparisons were found.

ANOVA for repeated measures showed, for lower Velocity after stimulation than both during (p<0.001) and before (p<0.001). No other significant post-hoc comparisons were found.

Table 2 reports the values of posturographic variables before, during and after central stimulation, after logarithmic transformation and adjusted for VAS-A as covariate, are reported in Table 2 in the Supplementary Material.

3.3. Posturographic variables and anxiety

3.3.1. Posturographic variables and anxiety during visual stimulation in peripheral visual field

ANOVA for repeated measures, with VAS-A scores during peripheral stimulation as covariate, showed, for Length, higher values in patients than controls, effect of Diagnosis (F=4.81, df=1.53, p<0.05), and an effect of Time (F = 8.73, df=2,106, p<0.001); post-hoc analyses for Time showed higher Length during peripheral stimulation than before (p<0.001) and lower Length after stimulation than during (p<0.001). No other significant post-hoc comparisons were found.

ANOVA for repeated measures, with VAS-A scores during peripheral stimulation as covariate, showed, for Velocity, higher values in patients than controls, effect of Diagnosis (F = 4.72, df=1.53, p<0.05), and an effect of Time (F = 8.70, df=2,106, p<0.001); post-hoc analyses for Time showed higher Velocity during peripheral stimulation than before (p<0.001) and lower Velocity after stimulation than during (p<0.001). No other significant post-hoc comparisons were found.

ANOVA for repeated measures, with VAS-A scores during peripheral stimulation as covariate, did not show, for Surface, effects of Diagnosis, Time or Time x Diagnosis.

ANOVA for repeated measures for Length, Velocity and Surface, with STAI-II scores, measuring trait anxiety, as covariate, showed similar results to those obtained without covariate, described in Section 3.2.1.

3.3.2. Posturographic variables and anxiety during visual stimulation in central visual field

ANOVA for repeated measures, with VAS-A scores during central stimulation as covariate, showed, for Length, an effect of Time (F=41.60, df=2,106, p<0.0001); post-hoc analyses for Time showed higher Velocity during stimulation than before (p<0.001) and lower Velocity after stimulation than both during (p<0.001) and before (p<0.001). No other significant post-hoc comparisons were found.

ANOVA for repeated measures, with VAS-A scores during central stimulation as covariate, showed, for Velocity, an effect of Time (F = 16.72, df=2,106, p<0.0001); post-hoc analyses for Time showed higher Velocity during stimulation than before (p<0.001) and lower Velocity after stimulation than both during (p<0.001) and before (p<0.001). No other significant post-hoc comparisons were found.

ANOVA for repeated measures for Length, Velocity and Surface, with STAI-II scores, measuring trait anxiety, as covariate, showed similar results to those obtained without covariate, described in Section 3.2.2.

Posturographic variables, during both peripheral and central stimulations, after logarithmic transformation and adjusted for VAS-A as covariate, did not influence neither the postural responses to peripheral stimulation nor those to central stimulation.

4. Discussion

We found that patients with PD and agoraphobia increased their body sway, indicating postural instability, during stimulation with real-world moving scenes in peripheral visual field whereas controls did not. Conversely, during stimulation in central visual field the two groups showed a similar increase of postural instability.

Compared to controls, patients showed higher trait anxiety and higher state anxiety during the procedure; analysing the body sway by covariance adjustments with anxiety scores, we found that state anxiety during peripheral stimulation significantly influenced the increase of body sway during peripheral stimulation in patients compared to controls, whereas state anxiety during central stimulation did not influence the course of postural response to central stimulation. Trait anxiety influenced neither the postural responses to peripheral stimulation nor those to central stimulation.

Previous studies showed visual dependence in patients with PD and agoraphobia (Jacob et al., 1995; Perna et al., 2001; Redfern et al., 2007); to this we added two new advances: these patients had higher postural sensitivity to moving stimuli, resembling natural environment, specifically placed in peripheral visual field and anxiety levels during peripheral vision influenced postural instability.

Peripheral vision has a critical role in our every-day lives, underlying the perception of self-motion and body stance in the environment and the ability to scan surroundings for changing conditions and to begin fast responses (Palmer and Rosa, 2006). Processing of peripheral visual information involves a fast pathway, encompassing the retinal magnocellular cells, the dorsal cortical...
stream and the limbic cortex (Kandell, 1991; Stephen et al., 2002; Palmer and Rosa, 2006). Moreover, a subcortical pathway (superior colliculus, pulvinar and amygdala), modulating reflexive responses to visual events processed without conscious awareness, arises from retinal magnocellular cells (Morris et al., 1999); thus, it may be also involved in behavioural responses to peripheral vision. Overall, peripheral vision seems to be engaged in orienting and defensive reactions to visual motion, involving short-latency postural adjustments as well as head and eye movements (Berencsi et al., 2005; Palmer and Rosa, 2006). On these bases, we might speculate that higher sensitivity to peripheral visual stimulation in patients with PD and agoraphobia may be linked to a more active “visual alarm system”, scanning the surrounding world; this may lead, by connections linking visual, vestibular and limbic areas (Balaban, 2002), to an increase in their postural sway when visual environment is changing in an uncertain way, such as during motion in peripheral visual field. Indeed, the influence of state anxiety on postural instability during peripheral stimulation supports the idea that this specific situation might have an emotional relevance for the patients, whereas different aversive stimuli do not (Favaron et al., 2010).

In healthy controls, the central vision is sensitive to optokinetic central stimulation inducing postural modifications, as previously reported (Warren and Kurtz, 1992). Contrary to peripheral stimulation, differences between patients and controls disappeared during motion in central field, when the details of objects near the focus of attention are available. Thus, the high sensitivity to complex sensorial environments in patients with PD and agoraphobia may involve a hypersensitivity to peculiar alarm triggers for visual-balanced connections. Similar conditions might occur in their every-day life, influencing clinical symptoms and phobic avoidance; accordingly, patients showed higher scores of Dizziness Handicap Inventory and VAS-Dizziness-in-every-day-life than controls.

It should be noted that an implication of the magnocellular system in abnormal visual information processing and visually driven attention has been suggested also in other psychiatric and neurodevelopmental disorders, such as schizophrenia and dyslexia, even though this issue is still debated (Stein, 2001; Laycock et al., 2008).

The higher sensitivity to visual peripheral motion in patients with PD and agoraphobia might arise from multiple sources. It might be a pre-existing idiosyncratic perceptual style, shaping the subsequent development of agoraphobia after the occurrence of panic attacks. In this respect, there are significant developmental changes over ontogenies; children often show amplified postural responses to peripheral visual stimulations which gradually recede towards adolescence (Baumberger et al., 2004; Palmer and Rosa, 2006), but multiple factors over time, including subclinical vestibular dysfunction, may affect the sensory re-weighting in behavioural responses to the environment (Mahboobin et al., 2005). Otherwise, this feature might be a consequence of PD and agoraphobia, acting as “disrupting” factors on balance control systems by vestibular-brainstem-limbic connections.

This study has potential limitations. We cannot exclude the possible influence of eye movements on the performances, although the subjects were instructed not to move head and gaze during the whole visual stimulation. The size of the sample was small, thus the results should be considered preliminary and need confirmation by studies in larger groups; future studies in groups of patients with PD without agoraphobia and with anxiety disorders different from PD are also warranted to investigate the specificity of the results. Moreover, to clarify the role of vestibular impairment in postural sensitivity to visual motion is warranted; even though the different responsiveness to central and peripheral stimulation would not support vestibular malfunction as primary explanation of our results, we cannot exclude an influence of vestibular abnormalities on our findings (Jacob et al., 2009). Further research investigating either the vestibular function in patients with PD with postural sensitivity to peripheral visual motion or the postural responses to peripheral/central visual motion in patients with vestibular impairment but without panic-phobic spectrum disorders might help to clarify this issue.

In conclusion, panic-phobic conditions might involve the activation of complex alarm systems (Bouton et al., 2001), that include interoceptive conditioning processes linked to destabilizing visual stimuli and operant learning processes related to the avoidance of visual experiences provoking discomfort in every-day life.

Appendix A. Supplementary data

Supplementary data associated with this article can be found, in the online version, at doi:10.1016/j.psychres.2010.05.012.

References


Please cite this article as: Caldirola, D., et al., Is there a hypersensitive visual alarm system in panic disorder?, Psychiatry Research (2010), doi:10.1016/j.psychres.2010.05.012.


Please cite this article as: Caldirola, D., et al., Is there a hypersensitive visual alarm system in panic disorder?, Psychiatry Research (2010), doi:10.1016/j.psychres.2010.05.012