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Abstract

Vertigo is a symptom caused by many recognised medical conditions, and treatment varies from physiotherapy and cognitive behavioural therapy, to medication and – in extreme cases – surgery. This paper begins with an Introductory Comment (Author A), which provides a brief medical definition and description of vertigo, and situates current clinical practice in the historical context of nineteenth century ideas about the impact of the city on mental and physical health. The main body of the paper draws on Author B's 30 years experience in clinical practice, providing a more detailed overview of the symptoms and causes of visual vertigo and discussing the impact of the urban environment on different patient groups, in terms of their experience of vertigo, their emotional response to particular kinds of space, and potential rehabilitation through a programme of desensitization.

Keywords	Vertigo; rehabilitation; anxiety; agoraphobia; urban environment

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HIGHLIGHTS

SICK IN THE CITY: A CLINICIAN'S PERSPECTIVE:

- An overview of a number of complex medical conditions which cause vertigo-like symptoms

- Practice-based insights from an experienced clinician who has treated visual vertigo patients for 30 years using a combination of physiological and psychological technoques

- Shows how the modern city triggers vertigo in multiple ways, not just through the experience of super-tall buildings

- An introductory comment draws links between today's clinical treatment of vertigo and the history of neuro-psychiatry and the study of emotional responses to the city.

SICK IN THE CITY: A CLINICIAN'S PERSPECTIVE

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SICK IN THE CITY

INTRODUCTORY COMMENTS
AUTHOR A

Almost everything we do in daily life depends on maintaining balance. This physical ability is determined by our vestibular system, which receives inputs from certain parts of the brain, the ear, the eyes and proprioceptors which detect movement (Martin 2015a). Loss of function in any of these systems – caused by infection, deterioration with age, or injury – can lead to problems with balance and associated symptoms of dizziness and spinning.

These disabling sensations are often described as vertigo, and can have a devastating impact on quality of life (Martin 2015b). There are over 350 medically recognised causes of vertigo, and treatment varies from physiotherapy and cognitive behavioural therapy, to medication and – in extreme cases – surgery (http://www.menieres.org.uk/information-and-support/symptoms-and-conditions, accessed 29 January 2018). The scale of the problem in the UK is unclear. Estimates of the occurrence of Méniére's disease – one of the better known causes of vertigo – for example, range from 1:1000 to 1:2000 (http://www.menieres.org.uk/information-and-support/symptoms-and-conditions/menieres-disease. Date Accessed 29 January 2018). But, in the US, the National Health and Nutrition Examination Survey (2001-4) suggested that 35% of adults over 40 years old – that's 69 million people – show evidence of vestibular dysfunction (Agrawal et al 2009, cited in Kyoung-Bok et al 2012).

For people with vestibular disorders, episodes of vertigo are rarely triggered by the experience of height alone but by simple bodily movement or visual stimuli and, significantly, the built environment itself. As a consequence, everyday life can pose considerable challenges. In 1995, Adolfo Bronstein identified a condition known as visual vertigo, in which attacks of dizziness, nausea and even migraine, are triggered by complex visual and moving environments (Bronstein 1995). For these patients, experiences which are commonplace in the contemporary high-tech, high-speed city, such as passing trains, flowing crowds, pulsating lights and digital screens, are especially problematic. And the effects of these motive landscapes are compounded by the material and architectural qualities shared by high-rise urban centres around the world. The seemingly ubiquitous use of glass and other reflective exterior surfaces increases glare at ground level and obscures visual contour lines essential for balance, rendering the street even more of a challenge for light-sensitive

patients. In other words, as cities become more densely packed and visually stimulating, they become increasingly inhospitable to populations prone to vertigo.

Despite a growing body of research on the health implications of global urban growth on specific populations,[1] the links between super-tall, super-fast and super-dense urban environments and vertigo have yet to be fully investigated from a health geography or public health perspective. Similarly, cultural geographers who explore the human experience of buildings and cities from a range of perspectives, including phenomenological, actor network and affect theory, have not yet turned their gaze to the ways in which vertigo-sufferers produce public urban space through complex emotional and sensory responses and embodied practices (Rose et al 2010). From a political-economy perspective, it is interesting to note that the shift towards neoliberal urbanism and the resulting growth of privately owned, tightly controlled public space in cities across the world in the last thirty years (see Pinson and Journel 2017 for an overview) has led to a steady decline in street furniture, parks and other forms of urban refuge (Mitchell 2016, Smith and Walters 2017) which, as Author B explains, play a vital role in enabling vertigo sufferers to participate in urban life.

Author B has 30 years of clinical experience in audiovestibular rehabilitation, working at the Royal National Throat, Nose and Ear Hospital (UCL). As a result of the unpleasantness of symptoms, often equated to sea-sickness, many of his/her patients report negative emotional responses to the urban environment, including aversion, fear and panic. Author B specialises in treating the secondary psycho-social symptoms of visual vertigo, such as agoraphobia and anxiety. In doing so, Author B follows a long-established medical tradition which investigates the impact of sensory and spatial factors on the health of the individual.

The idea that the city itself can trigger mental and physiological problems was first formulated by clinicians working in the emerging field of psycho-neurology in the late nineteenth century. At this time, urban space across Europe was undergoing a radical spatial and architectural transformation, and – in response – leading psychiatrists attempted to articulate the relationship between the modern cityscape and emotive conditions such as dizziness, vertigo and agoraphobia (Ghazal & Hinton 2016).[2] Then, as now, there was

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[1] See, for example, the *Place-Making with Older Adults* project, which investigates design interventions to enable active and healthy lifestyles for the growing number of older residents in cities. http://www.urbantransformations.ox.ac.uk/project/place-making-with-older-adults-towards-age-friendly-communities/#sthash.oCdNJVhQ.dpuf

[2] These clinicians include German Psychiatrist Carl Westphal (1833-90), Austrian neurologist Moritz Benedikt (1835-1920) and, in France, Henri Legrand du Saulle (1830-86).

considerable debate about the relative importance of *environmental* (i.e. the design and layout of cities), *emotional* (fear and anxiety) and *biological* (vision and balance) factors in causing and treating episodes of vertigo (Ghazal & Hinton 2016; Yardley 1994, p. 3-4).

This interest in the link between emotional and bodily responses to the city spread beyond clinical practice, and was taken up by writers and scholars who keenly documented the impact of modernity on the life of city-dwellers. At the beginning of the twentieth century, for example, pioneering sociologist Georg Simmel observed how, in order to cope with the ceaseless barrage of sensory stimuli, urbanites attempt to mentally and emotionally distance themselves from their environment. One of two responses results from this: most commonly, an indifference towards human relations – the blasé attitude – is assumed by people living in cities. In extreme cases, Simmel proposed, the response manifests itself as agoraphobia and hypersensitivity, which leads to a kinds of nervous breakdown (Levine 1971, p. 325; Frisby 1986, pp. 73-4).

A century later, Author B treats patients with an extreme sensitivity to urban stimuli, and uses visual exercises and behavioural techniques designed to 'desensitise' his/her patients to visual triggers they encounter in the city. It is fascinating to note that, while medical understanding of the causes of vertigo has evolved enormously since the nineteenth century, there remains a strong continuity in the blurring between psychological and physiological diagnosis and treatment. The nineteenth century idea that vertigo is a form of neuroses and that those who suffer from it are predisposed to hypochondria is – as Professor of Health Psychology, Lucy Yardley, acknowledges – still familiar today (Yardley 1994, p. 35).

A CLINICIANS PERSPECTIVE

AUTHOR B

As a clinical scientist specialising in rehabilitating balance disorders and working in an international centre for audiological medicine and research, I deal with a large number of medical conditions can make balancing difficult. I see around three hundred new patients each year and design individual rehabilitation programmes for them. Patients referred by an audiovestibular physician undergo an extensive array of diagnostic tests on the inner ear, including a rotating chair and a caloric test which provides a more accurate identification of the cause of dizziness. I also work with elderly and post-surgical patients referred by ENT

surgeons following removal of tumours. The duration of treatment varies from three months to three years, depending on the severity of the symptoms and the disability. The level of disability can be heightened by additional pathologies such as arthritis, fibromyalgia or migraine.

Most physiotherapists or audiological scientists use a range of standard physiotherapeutic techniques designed by Susan Herdman (2007) which are usefully combined with psychological techniques. These include autogenic training – a desensitization-relaxation technique developed by German psychiatrist Johannes Heinrich Schultz in the 1930s – for migrainous patients and paced breathing and relaxation techniques to treat hyperventilation syndrome, a precursor to panic disorder which is common among visual vertigo sufferers (Nestoriuk et al 2007; Kennerley 1991). In my own practice, I have found systematic desensitisation particularly effective in helping visual vertigo patients to cope better with visually complex urban environments and crowded places. This involves a walking programme, starting indoors, and building up through gardens and parks to eventually tackle crowds, busy city streets and supermarkets (Beyts 1997).

Medical conditions associated with vertigo-like symptoms, are more common than many people realise. Recent studies of the prevalence of migraine suggest that 16% of the population experience migraine across their lifetime, and 7% vertigo (Lempert and Neuhauser 2009). Vestibular migraine – a condition where patients suffer with episodes of both vertigo (sensations of spinning) and migraine (head pain, light sensitivity and other migraine symptoms) – affects about 5% of adults in one year (Neuhauser et al 2005). *In the US,* it is estimated that 45,500 new cases Ménière's disease are diagnosed each year (https://www.nidcd.nih.gov/health/menieres-disease. Date accessed 29 January 2018). Drawing on over 25 years' experience in clinical practice, this article focuses on the impact of the urban environment on different patient groups, both in terms of their experience of vertigo and their emotional response to particular kinds of space.

Normal and Abnormal Perception

There is a continuum of normal visual reactions to complex stimuli, visual stress, and visual vertigo which is worth exploring. Common visual illusions, such as the Necker Cube (see Fig. 1) illustrate the way in which we all constantly use our perceptual skills to hypothesise about our environments. Our capacity for three dimensional vision allows us to perceive three dimensions on two dimensional drawings – but, in doing so, the illusion of movement

occurs. Looking at the Necker Cube, for example, creates an illusion of flicker as the brain decides which side is closest to you (Gregory 1997).

Colour and tone can also trick the 'normal' brain into perceiving movement where there is none. A study of the physiological effect of Kitaoka's rotating snakes illusion (See Fig. 2) found that specific luminance detector neurones identified in the visual cortex of macaque monkeys explained why people to see movement in a static image (Conway et al 2005). In other words, juxtaposing paler shades of orange with yellow, black, grey and white in close proximity creates an illusion of movement because we are used to interpreting bright things as being closer than dark things.

There are many different visual illusions that can demonstrate how static images appear to move as our brains 'try out' different perceptual hypotheses (see Gregory 2015 for a full review). These experiments in 'normal' perception reveal why the changes that occur in patients with light sensitivity can be so disabling: we cannot turn off our brain's reliance on our senses and attempt to draw conclusions from our perception of reality. When these sensory and perceptual conclusions contradict eachother – such as the sensation of spinning when the standing still – the effect on anyone is extremely disturbing.

For people with vertigo-inducing medical conditions, this is part of everyday life. In so-called 'abnormal' reactions, patients report that during a shopping trip, for example, the parallel lines of a supermarket aisle and densely stacked shelves makes navigation difficult because of dizziness, or that flickering lights over a freezer section make it impossible to focus and likely to trigger a full blown migraine. Others report that the optokinetic effect of moving crowds or transport become destabilising. For many patients these are intermittent symptoms, which can be accompanied by disturbing, unpredictable vertigo attacks or migraines. Some patients cannot watch the scenery passing from a train or car window without developing motion sickness. Paradoxically, it is often the less intense effects of the environment which become more disabling so that shopping or travelling in any urban environment becomes over time very difficult and potentially dangerous.

Visual Vertigo, Anxiety and the Urban Environment

One of the most poorly understood groups who suffer from vertigo are those with visual vertigo, a symptom brought on by movements in the environment, and this article attempts to summarise the urban environmental conditions which can aggravate symptoms. Visual vertigo patients function best in static surroundings, so the landscape of the city, animated

by constantly moving crowds and traffic, is particularly likely to provoke sensations of instability and dizziness. Patients who are diagnosed with migrainous vertigo (one of the main causes of visual vertigo) find it especially difficult to process repetitive visual stimulation (Vasudeva et al, 2003). Most urbanites are able to 'tune out' these stimuli, or adapt by learning to ignore the flicker. But for visual vertigo patients this is impossible.

Most people can cope, for example, with a ride on a merry-go-round, where the surroundings become a pleasurable blur of colours. By contrast, a patient with migrainous vertigo would find this visually over-stimulating, resulting in an extreme and heightened illusion of movement (visual vertigo). The ride might induce a migraine, or motion sickness (Murdin, Davies et al, 2009). It is hardly surprising that, as a consequence of hypersensitive responses, patients with these diagnoses tend to avoid places such as fairgrounds. But, while it is relatively easy to avoid 'extraordinary' experiences which are likely to trigger an episode of vertigo such as a merry-go-round, patients who are prone to visual overstimulation face similar challenges in their everyday life.

Some balance disorder patients report difficulty with environments where there is either visual complexity (such as in supermarkets or large crowds) or flicker (such as cinemas, fluorescent lights, computer screens, or the view from a moving bus or train). Patients describe how travelling on the underground, for example, is especially unpleasant and induces feelings of panic. The moving escalators feel unstable, particularly if individuals also have motion sensitivity. They must avoid looking at the passing adverts, and the parallel lines of the steps themselves increase the intensity of dizziness or nausea. Once on the platform they stand with backs to the wall to counter the sensation of being sucked onto the rails as the train moves through the station.

Others explain how the combination of fluorescent light and crowded shelves in a supermarket provokes such strong feelings of vertigo that they are forced to take breaks, finding somewhere quiet to sit and recover, or to abandon the supermarket altogether. They have to hold onto the shopping trolley and, if the sensations become too intense, it can begin to feel very much like a visit to a fairground. They may need to abandon their shopping trip if the symptoms become too intense. Visual vertigo patients often develop an extreme aversion to places characterised by visually complexity. Conversely, many also avoid large open spaces where the lack of complexity makes it difficult to establish a stable fixation spot which is essential to maintain balance (Marks, 1981). Standing in the middle of a featureless park or football pitch might bring on a panic attack in space phobic patients.

Although we all use stable features of our environment as a way of getting our bearings, visual vertigo patients depend more heavily on set fixation spots (visual reference points which remain constant) to maintain gaze stability and to feel secure. Research using a modern form of balance testing (Computerised Dynamic Posturography) describes these patients as 'vision dependent' as they perform better in balance challenges with a fixed visual surround than a moving one (Nashner 1982,1990). As a result, these patients show a strong preference for indoor environments where there is not too much movement around them.

Because many of the most challenging environments are public spaces and buildings, patients present to their GP with symptoms of agoraphobia (Jacob et al,1989), an anxiety disorder characterized by fear and avoidance of places that induce feelings of panic. The blurred line between vestibular disorders and mental health issues is reflected in psychological research, which refers to the vision-dependent as 'space phobic' (Marks,1981). Most of us take our sense of balance for granted, and the strong emotional responses of patients to certain spaces and places can be difficult to articulate because it is not widely known about. They may be very anxious until they have a medical diagnosis which provides an explanation for why these environments have suddenly become so uncomfortable for them.

For migrainous vertigo patients, who are hypersensitive to high-contrast patterns and surfaces, the urban environment poses a rather different set of challenges. Bold graphics, repetitive stripes or black and white patterns – commonly found in metropolitan interior spaces, such as restaurants, galleries and public transport stations, are extremely over-stimulating and can trigger nausea in hypersensitive migrainous vertigo patients. To compound matters, some patients have an aura before their migraines where they become light and flicker sensitive (Pavlou et al 2006). Stairs with black and white or striped carpets, op-art paintings (a form of abstract art that gives the illusion of movement) or areas of wallpaper with repetitive geometric patterns, are distressing to patients who are contour sensitive. Many patients have such a strong avoidance reaction that they feel unable to climb the stairs and become immobilised (see Figures 3 and 4).

In an urban environment which is destabilizing in this way, panic attacks can develop. One of the physiological precursors of a panic attack is hyperventilation. Fiermonte et al (1995) reports that patients with migraine and aura are particularly sensitive to the physiological changes that occur during hyperventilation and panic attacks, which can result in chronic or habitual physiological changes, which worsen their migraine symptoms. This group can

develop serious panic disorder and experience extreme difficulty navigating visually complex surroundings such as supermarkets.

MARD

There is a large body of work on the stressful effects of having vertigo attacks. The recent identification of Migraine and Anxiety Related Dizziness or MARD (Furman et al 2005) reflects the fact that being sensitive to light and flicker renders a wide range of urban environments so stressful that anxiety symptoms and migraine have becomes closely associated.

Most people are aware of the fact that migraineurs can develop photo sensitivity but the difficulties habituating to repetitive visual stimulation are less well known. This group of visually hypersensitive patients can be markedly disabled if they live in an urban setting because most streets have movement in them from either pedestrians, or traffic. Typically, patients report that when they walk along on the street, they study the pavements closely in order to spot potential trip hazards, and because the motion of passing pedestrians make them feel unsteady.

There is a growing awareness that migraine can cause anxiety. When this in turn causes hyperventilation syndrome and panic attacks it become even more disabling. Looking up for too long can, in some patients, also trigger dizziness and stress. Often patients will only venture out with a chaperone, or wearing dark glasses or a hat to reduce the glare from the sun or the strength of bright stimuli, such as tall buildings with lots of reflective surfaces causing glare or from overhead lighting. In these ways, the modern city environment is increasingly inhospitable for migraine sufferers, exacerbating their symptoms.

For many patients this is only an intermittent problem but for more severe cases, where hyperventilation has also caused semi-habitual vasodilation and vasoconstriction, it can become a semi-permanent symptom (Radat and Swendsen 2005). It can be extremely distressing to live with a permanent sensation of imbalance. Differential diagnosis in this area can be difficult but a good discussion is available in Lempert, and Bisdorf (2012)

As this overview illustrates, the experience of 'feeling sick in the city' is a more complex and widespread phenomenon than is often acknowledged. Since these patient groups present extreme and sometime conflicting requirements, it is particularly difficult for architects and planners to provide comprehensive design interventions to make the urban environment

more accessible. The two so-called 'phobic' groups, for example, present contrasting and conflicting needs: one hates complex visual environments and flicker (agoraphobic), whilst the other dislikes wide open spaces with too little to focus on (space-phobics), and they are both vision-dependent in their mode of balance. However, simple things, such as providing rest stops and seating in places such as supermarkets or crowded streets provides invaluable opportunities for a range of patients to feel secure and recover during an attack of imbalance or vertigo.

Rehabilitation

There are also various strategies which patients themselves can use to help maintain balance in environments likely to trigger vertigo. In visual vertigo patients, optokinetic desensitisation is one method of retraining the vestibular system (Pavlou et al 2004). Provided the visual vertigo patient can be initially exposed to a visual stimulus for a very limited time, they can gradually be desensitised. This treatment works by carefully stimulating the uncomfortable sensations of imbalance in small doses, and then letting them fade away (while the patient is seated and feels safe) so that the brain undergoes the recovery processes of sensory reintegration.

The degree of hypersensitivity can often be so pronounced that the patient is overwhelmed by anything other than the briefest of exposures to optokinetic stimuli. Parallel lines on walls and even metal railings in the street can all cause optokinetic stimulation as the patient walks past them. This induces feelings unsteadinnes, dizzinness or nausea. However, if the duration and speed of the lines in motion can be mechanically increased in small increments, with reassurance, it is possible to gradually desensitise patients and enable them to cope better in visually complex environments (Pavlou 2010).

Herdman (2007) has devised some eye exercises which use a chessboard to expose the visual system to repeated contour lines in very small doses so that visual vertigo patients can gradually start to desensitise themselves to contour lines, whilst in the relative safety of their own homes. But they cannot do these exercises while they have a headache or migraine, as their visual system is too sensitive. In the context of rehabilitation, environmental triggers such as parallel lines and repeating patterns are actually beneficial providing the opportunity for desensitisation. In milder cases, this can happen naturally if the person walks around a city in order to build a tolerance for milder sensations of vertigo.

Eventually, the treatment goals are made more difficult so that this retraining occurs over an extended period of weeks or months (Beyts 1987,1997). It can also greatly help the recovery process to avoid edible migraine triggers like caffeine, strong cheeses, and chocolate (Tusa R 2007).

Environmental needs for the Elderly

Balance problems in the elderly require a different clinical approach because they generally result from a combination of musculoskeletal problems, such as cervical spondylitis, and visual deficits, such as cataracts or macular degeneration. In particular, these two ocular deficits make it difficult to perceive details like the edges of stairs, and can make everyday life very challenging. Ideally, older vestibular disorder patients would have their living environments adapted so that they felt safe, and were safer living in them. Recommended adaptations to the interior of the house would be of equal benefit in the public realm and urban environment. For example, ensuring there is adequate lighting on staircases, and lighting that does not cause glare on floors. Black, Mackie and Fernie (1993) recommend bright vivid colours so that the contours of interior or street features really stand out which would be helpful for those with visual challenges such as macular degeneration, or cataracts.

Patients with balance problems are doubly disadvantaged if they have arthritis or have had knee or hip replacement surgery, as this can lead to impaired or altered proprioceptive feedback from their joints. As proprioception is one of the three senses of balance, this can be rather disabling. Any surface challenge such as loose gravel or cobbled streets can be difficult to walk across. If there is impaired ankle vibration sense, then responses may be grossly impaired making it very unsafe for patients to navigate without an escort, handrail or other walking aid. Pynoon et al (2010, 2012) offer useful reviews for modifications for building for the elderly.

Sloping walking surfaces are perceived as safer than stairs. However, they can pose specific problems for the elderly, especially during balance rehabilitation, because changes in gravitational pull on ascending or descending slopes are very subtle. Patients report having to walk really slowly on slopes because they feel an increased sense of danger. Consequently, railings and grab bars can be very helpful in preventing falls on sloping walkways. Patients may have to relearn how to use slopes after an ear infection, or other intermittent balance problem.

Conclusions

There is a huge range of ways in which the environment affects patients with vestibular disorders. In cases of vestibular migraine or visual vertigo, finding an optimal level of lighting can be particularly difficult as patients have differing levels of photosensitivity at different times, being most sensitive either before or during their migraines. Some are also quite unable to walk comfortably in situations where the light is poor or absent. They need encouragement to adapt to carrying a torch with them, or adequate lighting will need to be provided. Furthermore, they can also be hypersensitive to flicker or movement in their environment, which can cause visual vertigo.

There is also a wide range of individual differences in balance patients, as some patients are space phobic, and find the absence of fixation spots in wide open spaces destabilises them, while others find that too many contour lines make them hypersensitive. Even within the young there are patients who are surface-dependent, meaning that they walk more comfortably on flat surfaces than on cobbled streets, sand, or snow. Patients who are visually and proprioceptively-challenged have invisible disabilities, unlike the elderly who frequently will need a more visible walking stick, or walking frame to help them get about safely.

In the elderly there are often multifactorial causes of balancing difficulties and surface challenges, such as sloped or cobbled streets, can exacerbate their condition. Bland visual environments and poor lighting may not offer enough contour information for them to move around safely if they have visual deficits like macular degeneration or cataracts. Each patient will have an individual pattern of disabilities, some of which may be invisible, or unknown, prior to medical examination. Sometimes the elderly themselves cannot easily explain the changes in their physical abilities and why this has made certain environments difficult to manage.

The lowered confidence of patients with chronic balance problems can lead to a marked avoidance of certain environments, and a tendency to withdraw from going outdoors. Some can go on to develop problems with anxiety or feelings of panic, and many may not be aware that they may have a visual sensitivity to crowds or contour lines due to their medical condition. It is also possible that some agoraphobics may not have been diagnosed correctly and have visual sensitivities caused by either migrainous vertigo or other causes of balance

disorders. With the correct medical and physiotherapeutic help, however, even the most complex of these patients can be helped.

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Figure 1. The Necker cube.

First published in 1832 by Swiss crystallographer Louis Albert Necker, this type of illusion shows us how our brains are constantly generating theories about how to interpret our environments.

Figure 2. Rotating Snakes Illusion (Conway & Kitaoka, 2005)

This piece of op-art belongs to the class of 'Peripheral Drift' illusions and evokes a strong perception of rotation.

Figure 3. The Optokinetic Staircase

The striped wallpaper and contrasting lines of the staircase present a powerful set of stimuli for visual vertigo patients, who would struggle to climb it with their eyes open.

Figure 4. Repetitive black and white designs.

High-contrast wall and floor tiles would be too intrusive for the contour sensitive, causing retinal slip (images which move across the retina) and proving very challenging to walk across.