CHAPTER THREE: PHYSICAL ACTIVITY AND THE ENVIRONMENT

Physical consequences of vertigo

The physical characteristics of vertigo (detailed in Chapter 1) comprise, firstly, the disorientation and loss of postural and ocular control that characterises balance system dysfunction and, secondly, the ancillary autonomic symptoms such as cold sweating, nausea and vomiting which are triggered by perceptual disorientation. The immediate physical consequence of an acute attack is therefore virtual incapacity. The sufferer cannot stand or walk and may not even be able to focus properly owing to involuntary eye-movements, and must therefore simply lie still in bed, avoiding any head movements which might stimulate the vestibular system and thus exacerbate the dizziness. Since the process of compensation is quite rapid, this state of severe disability rarely lasts for more than an hour or two. However, until complete habituation is achieved, any rapid or unaccustomed movement will provoke further symptoms, resulting in a less extreme but nevertheless significant degree of interference with physical activity. The many ways in which physical activity is typically affected by vertigo are summarised in Table 1, which lists the forms of disability reported most frequently in interviews with people with vertigo (Yardley, Todd et al., 1992). The far-reaching effects of residual, movement-provoked vertigo on physical activity are more graphically described in the following quotations:

> If I get up very quickly I get it [vertigo], if I bend down I get it, if I bend, if I stretch, if I look up it starts me up, if I turn I get giddy -- I can't turn that side.

> I get out of bed very slowly, like a zombie. I've learned not to bend and not to turn quickly. I never look at my feet -- if I drop things I wouldn't dream of bending down to pick it up.

It is evident from these reports of significant disability that recurring vertigo is not simply an unpleasant experience, but can have an extensive impact on various areas of normal activity. A large proportion of the people interviewed had found that tilting the head or bending over provoked vertigo, and that this caused problems with such routine chores as tending the garden, transferring shopping to and from trolleys, or washing their hair. Difficulty in focusing the eyes sometimes affected pastimes such as reading, knitting and sewing. A common experience was that susceptibility to travel sickness had greatly increased (see following section), and this interfered with long journeys and holidays. Persistent unsteadiness or the possibility of a sudden unexpected attack rendered some tasks too risky or responsible to be undertaken; the majority were obliged to give up driving, and some reported being unable to operate machinery, supervise children, cycle, or swim. In addition, many physical leisure pursuits, such as dancing and exercise, induced such disagreeable sensations of imbalance and nausea that they no longer seemed worth pursuing.

Table 1. Disability and anticipatory disability resulting from vertigo.

<u>Physical measures for coping with an attack</u>

Sit, lie down, rest, move slowly, avoid bending or turning, hold on to support.

Restriction of activity resulting from vertigo

Normal daily activities: unable to wash, shop, cook, perform household chores/routine maintenance.

Obliged to avoid/restrict participation in a) physically active leisure pursuits (e.g. dancing, rambling, keep-fit, swimming, riding bikes, various sports, gardening) and b) less active leisure pursuits (e.g. reading, knitting, sewing, classes).

Unable to drive, or travel by bus, train, bicycle, plane, car, or on escalators.

From the explanations given for the various instances of disability, it appears that although some of the disability caused by vertigo is the direct result of loss of postural control and general malaise, much of the restriction of activity is not due to current physical incapacity. Indeed, when the extent of the handicap resulting from vertigo is compared with the frequency and severity of symptoms, it is clear that quite limited and isolated episodes of dizziness may nevertheless be associated with prolonged and substantial restrictions on lifestyle (Yardley, Luxon & Haacke, 1993). The apparent discrepancy between the incidence and degree of physical incapacity and the consequent disability can be explained in terms of the rational response of sufferers to symptoms provoked by movement, which is to avoid any activities which seem to trigger vertigo. Such deliberate restriction of activity has been termed "anticipatory disability" (Cioffi, 1991).

Anticipatory disability is sometimes ascribed to a fearful or passive mode of responding to physical ailments. This interpretation of self-imposed restrictions on lifestyle seems justified when the sole purpose is to avoid provoking sensations that the sufferer finds unpleasant -- for example, when people with vertigo restrict their movements simply in order to avoid provoking disagreeable symptoms. However, the unpredictability and uncertainty surrounding vertigo provide two further compelling reasons why even the most stoic and energetic of individuals might think it best to avoid activity. Firstly, an important rationale for restricting physical movement emanates from the suspicion or belief that, since movement is unmistakably linked to the onset of sensations of dizziness, immoderate levels of activity could trigger a full-scale attack. The following accounts of clearly demonstrate that sufferers find it difficult to distinguish between dizziness induced by head movement and the initial stages of an acute episode of vertigo:

> I would feel light-headed if I was bending down, dress-making or anything like that (I tend to do it on the floor). It would tend to make me feel a little bit dizzy, which would sometimes trigger off a dizzy attack.

> I have to be ever so careful how I move and what I do. Every time I bend my head down I have this really awful giddy head --

> last time I went to the Bingo I had to sort of sit and hold my head still while I try and mark off the numbers. I went into the DIY shops, and I had to come out because it was making me sick sort of going around looking at things and sort of moving my head around. The movement of my head seemed to -- I don't know whether that's what set it off, but that's what it appeared. Even now, if I have to turn round quick and then have to turn back again, I feel that it's going to come on.

The (essentially erroneous) belief that movement might actually be the cause of acute attacks of vertigo was presented by some people as a possible justification for espousing complete immobility as a logical preventative or coping strategy:

> I suppose if you were clever enough just to go to bed, lay down twenty-four hours before the attack really materialised you might have been able to stabilise it that way.

> I mean I haven't been doing anything, full-stop. Whether or not it is just complete rest [that is needed] I don't know. I mean, not working, just sitting in a chair doing what you want all day, whether or not that is giving the body rest, time to recuperate I don't know, I have got no idea. All I know is I am not getting up, the usual routine, and going out to work, tearing back and cooking a meal and all that goes with it.

These quotations illustrate the immense potential for anticipatory disability which can result from ignorance of the distinction between spontaneous attacks, which are caused by internal damage to the vestibular organ and are quite unrelated to activity, and the movement-provoked vertigo which constitutes a necessary and harmless, albeit disagreeable, part of the process of compensation. Although the symptoms provoked by movement may indeed be very similar to those experienced during a mild spontaneous attack, awareness of the entirely different causes and implications of spontaneous and provoked disorientation would permit sufferers to regulate their activity levels in a more informed and appropriate manner.

A second motivation for refraining from certain activities is the, often very real, possibility of causing harm to oneself or to others whilst incapacitated; examples of actual mishap given by the interviewees included staggering into furniture, tripping over, and even falling under a lorry. Since many people find that an attack can occur at any time, virtually without warning, a prudent strategy is to avoid all activities which could prove dangerous if disrupted by sudden dizziness. Driving was the most commonly reported instance of an activity of this kind, although many interviewees felt that the handicapping consequences of giving up driving would be so severe that they preferred to trust that they would be able to stop the car safely when an attack began. However, numerous additional instances were given of activities considered too potentially dangerous to undertake, from scaffolding to stage-lighting, and from crossing roads to climbing stairs.

The extent to which vertigo represents a potential danger varies according to the activities the individual is typically engaged in; hence, the

interviewees who were required by their occupations to scale heights or operate dangerous machinery were more handicapped than those who had office jobs. The threat posed by vertigo also depends upon the physical resources that the individual is able to call upon to prevent or to cope with the possibility of falling. This could partly explain why increasing age has been shown to augment the level of disability resulting from vertigo (Yardley, Verschuur et al., 1992). Even a mild vestibular lesion may cause significant disruption to postural control in people with multiple minor sensory or motor impairments (as is often the case in the elderly). They may be unable to substitute or correct for absent or altered vestibular information owing to poor vision or reduced somatosensory function in the lower limbs. Moreover, because they have generally slower reflexes, reduced joint mobility and less muscular strength, older people are less able to correct their posture once they have begun to overbalance. In addition, not only do older individuals find it more difficult to accommodate or compensate for a partial, momentary loss of equilibrium, but they may also find the physical consequences of an actual fall are more damaging, owing to brittle bones and reduced recuperative powers.

Vertigo can cause secondary physical harm not only by inducing falls, but as the result of the physical strategies adopted to prevent or cope with dizziness. One of the most common side-effects of attempting to avoid head movement is the development of a stiff neck, which can also lead to severe headache. Often sufferers are quite unaware that they have unconsciously adopted a rigid head posture, and assume that the headaches are simply an integral part of the syndrome of dizziness, nausea and general malaise. Ironically, cervical (neck) disorder is itself believed by many clinicians to cause dizziness, either by distorting the somatosensory input from the neck or by disrupting the vascular supply to the inner ear (de Jong & Bles, 1986; Oosterveld, 1984; Pfaltz, 1984). Although cervical disorders may be caused by spontaneous degeneration or disease, they can be exacerbated by deliberately maintaining an overly rigid head posture. Hence, by employing a stiff upright head posture to cope with residual dizziness due to a vestibular disorder it is possible that people may actually compound the causes of their dizziness. In addition, a general loss of fitness and mobility, sometimes accompanied by weight gain, is a common long-term effect of the restriction of physical activity associated with chronic vertigo, since sufferers generally abandon all forms of sport and vigorous exercise.

The consequences of restricting head and body movement have social as well as physical dimensions. Mauss (1979) notes that there are socially specific modes of performing any physical movement, which will vary according to the social characteristics of the individual, such as their culture, age and status. Posture and head movement constitute an important non-verbal channel of communication, which can convey attitudes such as interest, dominance or assent. The postural strategies used to cope with vertigo can affect the non-verbal element of social relations in subtle but important ways:

> You don't look at somebody who approaches you from the right hand side, you wait until they get right round before you talk to them. If anyone's talking to me, I would mostly stand up and talk to them, I wouldn't look up at them.

Toombs (1992) has pointed out that, in social terms, the body can be considered as a meaningful gestural display. In this respect, people who change their behaviour as a result of vertigo may be concerned about the negative impression that their physical caution might make on observers:

> People might say "Run along the road, jump in the air, do all sorts of things", but I won't do those things. I am unfit anyway, but I am frightened of bringing on an attack. Running around, mucking about, being playful really -- you know, anything like that I am very wary of ... these elaborate fairs they have now, lots of things I will avoid. It does put a dampener, you know, if you want to be a fun person.

> I take a little bit longer about everything; people will say that's age, but it isn't age, its because I'm frightened of falling over.

Moreover, the somewhat defensive tone of these quotations suggests that the unflattering perceptions attributed to observers, such as slowness and lack of spontaneity, may be partly internalised, resulting in a negative body-image or even self-image.

Toombs also notes that under normal circumstances we are unaware of our body, which simply constitutes the means employed for the purpose of activity. Only when activity is disrupted by physical malfunction does the body become the focus of our attention, and in this context it is perceived as defective, and in opposition to the self. Some of the comments made by interviewees confirmed that a sense of being aware of and alienated from one's own body could be induced by the unaccustomed disorientation and loss of control:

> You could be all right one moment and then its like throwing a switch, and you feel quite ill -- not ill, you become very tense and very introspective of yourself, almost as if there'd been a chemical switch in your body.

> I reckon it hits you a bit like having a close death in the family; your body has been changed, its out of your hands -- part of you is not the same, will never be the same again.

In sum, the physical consequences of vertigo, while unpleasant and frustrating in themselves, can have much more profound implications through their indirect psychosocial impact. Restrictions on activities such as driving and physical exertion, adopted either out of necessity or concern about physical danger, or motivated by fear of provoking attacks, may force some individuals to give up work and impose limitations on the independence and social activities of many others. Similarly, abandoning active leisure pursuits such as dancing and rambling can cause a range of adverse secondary effects, from becoming fat and unfit to losing contact with valued social networks. The net result may be a self-image of apparent premature ageing, as the individual finds him or herself confined to moving stiffly and cautiously around the home. The multiple ways in which physical disability caused by vertigo can lead to further physical problems, social difficulties and psychological distress are eloquently

exemplified in the reply of one young woman to the question "In what way is vertigo affecting your life?":

> Well, it obviously affects pleasure, all aspects of pleasure. You know, I need to exercise for fitness. There are things I want to do just for my reasons. Sex it affects -- you try to romp around the bed with somebody. So what it has done is has affected my sex life like anything, because I am too frightened of getting dizzy so I will avoid it. It has affected my work in the sense that I will get somebody else to do something rather than me, like bend down or do this, that and the other -- I feel guilty about it because it is unfair. The travelling; I panic if I have to get in a car and sit at the back seat, so I push and bully to get in the front seat. And anything that would really trigger it -- sitting upright in the morning I get out of bed very slowly. This makes me feel like an old person, which is awful, I feel very old and decrepit. I try not to turn round suddenly -- I feel like I have got a brace around my neck most of the time. I wake up with these stiff necks a lot of mornings, and I think "Why is this?", and I am sure some of this is worry and tension, and I think it is the fact that I am walking around continuously like I am a Munster [a stiffly-moving zombie character on television]

Parallels with motion sickness

In the preceding section, attention was focused on the bodily consequences of vertigo and the way in which the physical activities of the individual affect and are affected by vertigo. However, disorientation is not an internal somatic sensation, located within the body, but an awareness of a disturbed relationship with the environment. Indeed, vertigo is frequently described by sufferers in terms of an uncertain orientation with respect to the environment, or is explicitly portrayed as an alarming motion of the environment itself:

> Sometimes you don't know which way up you are -- it's really strange.
>
> Every time I looked up the room used to spin round, the whole ceiling just spun.
>
> One time I was watching television and the television was going round and round, the whole set appeared to go round and round. If you shut your eyes everything would still go round and round, so it was frightening in that respect.

These phenomenological accounts depict the experience of vertigo as arising at the interface between the individual and their surroundings, rather than within the individual. It is certainly the case that equilibrium demands coordination between the individual and environment; physical activity must be accurately calibrated to match external conditions. Hence, in the same way that a change in the usual pattern of signals from the vestibular organ can result in vertigo, disorientation, imbalance and sickness can be caused by unfamiliar or altered environmental conditions. Some clinicians have therefore suggested that motion sickness can be considered as a special case of vertigo (Brandt & Daroff, 1979), since the symptoms of motion sickness and vertigo are very similar, and a similar pattern of gradual adaptation mediates recovery from both forms of disorientation. The correspondence between the subjective experience of disorientation caused by internal and external conditions is also recognised by people who have experienced both, as a former aviator explained:

> It [the onset of vertigo] stopped me from wanting to fly. I used to like plane loop-the-loops and all those sort of things when I was younger, and I was going to start to take it up again, but I decided that vertigo was quite a sufficient sensation by itself -- you've got your own personal simulator!

Motion sickness and vertigo both appear to be triggered only by disorientation involving the vestibular system; for example, when disruption to orientation and balance is due to disorders which result in peripheral somatosensory dysfunction or loss of motor control, no dizziness or nausea is provoked. It is possible that the evolutionary purpose of the syndrome of vertigo and motion sickness is specifically to alert the animal or human concerned to a balance system dysfunction caused by vestibular failure, and to promote appropriate behavioural responses (chiefly, immobility while dangerously uncoordinated) and physiological reactions (such as vomiting, to expel any

poisonous substance which may have caused the dysfunction). Deficiencies in perception or motor control caused by other types of sensory or motor dysfunction can be signalled by modality-specific, localised symptoms such as pain, numbness, weakness, loss of sensation, blurring or blindness. However, the vestibular system has evolved in such a way that it functions only in conjunction with other sensory and motor systems, and on its own yields no distinct sensations. Therefore, a dysfunction of the vestibular system can only be identified indirectly. Vertigo or motion sickness consequently occurs whenever a persistent breakdown in perceptual coordination and control of orientation occurs for which no other obvious internal or external cause can be detected, hence signalling a probable disruption of vestibular functioning. This is why the syndrome is not provoked by orientation difficulties due to darkness or blindness, or the coordination problems caused by entering a new medium such as water, or attempting to maintain balance during a new mode of locomotion, such as ski-ing or cycling. In contrast, although the fact of disorientation due either to vestibular dysfunction or to sea or space travel is apparent, but the ambiguities in the vestibular information which result in disorientation in these situations, although they can be explained in terms of the mechanics and functioning of the vestibular system, are certainly not immediately obvious to the individual concerned.

Before the invention of the passive modes of transport and artificial environments which nowadays provoke sickness, any prolonged alteration in the way in which the animal must interact perceptually with the environment for the purposes of orientation was likely to be due to vestibular dysfunction. Vertigo may therefore be the prototypical case of "motion sickness", and the original cause for the syndrome. Because of the adaptable nature of the orientation system, awareness of inexplicable disorientation is a particularly suitable means of alerting an animal to vestibular dysfunction. Clearly, what is important to the animal is its state of coordination, rather than the absolute level of vestibular functioning. This information can be provided by a syndrome which is provoked indirectly, through the awareness of disorientation. The extremely variable pattern and time-course of adaptation which characterises recovery from vertigo is, by this mechanism, precisely shadowed by symptoms of vertigo; consequently, these symptoms provide the animal with an up-to-date index of its level of coordination.

Recognition of the close parallels between vertigo and motion sickness can provide a valuable source of insights into the way in which environmental factors may affect people with vertigo. Examination of responses to clinical vertigo is complicated by variations in pathology, which cannot be accurately assessed, and secondary adaptations to chronic balance problems. In contrast, motion sickness can be provoked in controllable, isolated episodes, using standardised stimuli, allowing normal responses to challenges to the orientation system to be examined. By drawing upon experimental studies of motion sickness it is therefore possible to derive insights into vertigo which would be difficult to obtain by means of investigations set in the context of naturally occurring pathology and the multi-faceted, uncontrolled experiences of patients. Principles governing provocation of motion sickness and adaptation to disorientation in healthy people can then be extended to the case of those suffering from vertigo.

Three important conclusions can be derived from the copious studies of

motion sickness (for a detailed review, see Yardley, 1992a, 1992b). The first is that an individual's reactions to disorienting conditions are partly situation-specific, so that people who are quite disorientated by the vertical motion of waves may be completely undisturbed by the confusing visual environment of a flight simulator. This finding has obvious implications for evaluation of orientation system dysfunction; accurate assessment of disability is more likely to be achieved under test conditions which differ as little as possible from the circumstances that the individual finds disorienting in everyday life. This may partly explain why the results of the traditional tests of vestibular function, which chiefly involve measuring the eye-movements of an immobile patient in the dark, often yield negative results in patients with symptoms which nevertheless strongly suggest balance system dysfunction. The fact that disorientation may be experienced only in certain situations or when performing particular orientation tasks is appreciated by clinicians such as Norré, who recommends multiple assessments of compensation for vestibular dysfunction, including evaluation of nystagmus and vertigo resulting from position, movement, visual stimuli, and rotation (at several different frequencies), and postural instability under various conditions (Norré, 1988; Norré et al., 1984). Norré has observed that a patient may display no evidence of functional abnormality when rotated at low speeds, whereas high speed rotation may produce clear signs of a failure to adapt to vestibular imbalance (or vice versa). Similarly, the pace and stage of adaptation of the vestibulo-ocular reflex can be markedly dissociated from compensation in terms of vestibular control of posture; consequently, someone who has completely normal eye movements may still experience great difficulty in balancing. In addition, dysfunction may be apparent only under particular perceptual conditions; for example, when visual cues for orientation are unusual or misleading (see section on "visual vertigo" in this chapter).

A second principle that can be inferred from research into disorientation is that the perceptual-motor experience, skills and activities of the individual concerned can affect their reaction to a potentially disorienting environment. Experience of disorienting conditions may result in the development of appropriate strategies for coping with them; Fukuda (1975) has noticed that bus drivers lean in the opposite direction to passengers when navigating a bend, and such postural strategies may well be relevant to the common observation that people are more resistant to motion sickness while driving a vehicle than when they are passengers (Benson, 1984). On the other hand, perceptual "habits" learned in one environment may prove maladaptive in some situations. For example, experienced pilots, who have a keen appreciation of the patterns of perceptual information to be expected in flight, actually become more disoriented (and sick) in flight simulators than do novice pilots (Crowley, 1987); the "cabin" environment seems to specify the perceptual conditions pertaining during flight and therefore cues the use of orientation information appropriate to flying, but actually the perceptual information in a simulator is not quite the same as in a real aeroplane.

In clinical terms this implies that, in addition to assessing the basic input from each sensory system, it is essential to consider the way in which the individual attends to and combines these signals. For example, following a transient vestibular disorder many people fully recover the vestibular input they temporarily lost, but experience continued imbalance. Often these individuals

have normal vestibular responses to caloric stimulation, but do not appear to use vestibular information for postural control; presumably they automatically adjust to the initial disorder by ignoring or suppressing the distorted vestibular input, but then fail to abandon this perceptual strategy even though the vestibular information is once again accurate and useful. Since the utilisation of sensory information depends upon the characteristics and activities of the individual concerned, these can strongly influence the resulting degree and form of functional disability. This may further explain the limited ability of clinical tests to predict disorientation in everyday situations; whereas the clinical vestibular tests assess the semi-automatic reflexes of patients passively exposed to vestibular stimulation, vertigo in everyday life may either be prevented or provoked by the perceptual-motor strategies used by these individuals to cope with a variety of environments. New tests are already being developed to supplement the traditional vestibular test battery by providing a more complete and naturalistic assessment of orientation system function or disability, and for monitoring the state of compensation the patient has achieved. Examples include the measurement of eye-movements induced by rotation at a wide range of frequencies (Allum et al., 1989; Cyr et al., 1989) or by actively and rapidly shaking the head (Takahashi et al., 1990), evaluation of the way in which patients use visual, vestibular and somatosensory information for postural control (Nashner et al., 1982), and the ability of people with vestibular deficiencies to judge the distance they are turned in the dark.

The third conclusion that can be derived from the literature on motion sickness is that, at least in healthy people, the degree of malaise provoked by disorienting conditions seems to depend less on their immediate reactions than on their ability to adapt to these conditions. If this principle applies equally to the case of disorientation in people with vertigo, it follows that whereas the number and severity of vertiginous attacks is determined by pathology, individual differences in the persistence of malaise and disability are determined by the ability to adapt -- or, in clinical terms, to compensate. This conclusion acquires particular significance in the light of the evidence, detailed in the following chapters, suggesting that the emotional distress often felt by people with vertigo is more closely related to chronic disability and handicap than to the frequency and severity of episodes of acute disorientation. The processes involved in adapting to disorientation therefore deserve more careful consideration.

Adaptation and learning

Immediate adaptation following an acute vestibular episode appears to proceed partly by means of some semi-automatic neurological processes; for example, in order to reduce the vestibular imbalance, vestibular signals from the healthy vestibular organ may be partially suppressed by the central nervous system for several weeks. Longer-term compensation for vestibular impairment involves a process sometimes referred to as "central recalibration", whereby the balance system adjusts to the new pattern of sensory information which now accompanies each head movement (see Chapter 1). By means of central recalibration the orientation system gradually attains a new equilibrium, which is manifested at the neurological level as recovery of vestibular-related activity at the level of the brainstem (i.e. in the vestibular nuclei of the impaired vestibular system), despite permanent damage to the peripheral vestibular organ.

The progressive supplementation or replacement of lost vestibular information by information from the healthy vestibular sensors and the visual and somatosensory systems occurs as the result of repeated experience of movement. Consequently, the "recalibration" element of habituation is quite movement- and situation-specific; only those combinations of sensory input that are experienced many times cease to provoke disorientation and sickness. The implication is that any unaccustomed movement or environment will continue to cause difficulties; although vertigo may not be induced by routine activities, a twist of the head performed more quickly than usual or a trip on a ferry may unexpectedly cause renewed dizziness and nausea.

However, research into motion sickness suggests that in addition to this principal, localised form of habituation it is possible to acquire a degree of general resistance to disorientation. There may be several different forms of generalisation of habituation. One example is the fairly substantial transfer of adaptation from a certain motion to a set of similar motions. For example, habituation to rotation in one direction transfers to some extent to rotation in the opposite direction, and adaptation to precise left-right or fore-aft head movements performed while rotating generalises to multidirectional head movements (Reason & Brand, 1975). This kind of transfer is exploited by treatment programmes designed to provide protective adaptation for chronically motion sick aviators (e.g. Stott, 1990). These programmes often employ exposure to a highly circumscribed set of activities and perceptual conditions, such as performing stereotyped head movements in a rotating chair, to increase tolerance of the much more diverse and complex activities and perceptual conditions which provoke sickness during flight.

A general resistance to disorientation is often seen in people whose occupations involve repeated exposure to unusual motion, such as sailors, pilots, and athletes (Dowd & Cramer, 1971; Hood, 1984). Dancers and skaters provide a particularly instructive example of generalised resistance to orientation. Dancers are less influenced than most people by misleading visual information about the location of their body parts provided by distorting prisms, and are able to retain a relatively precise sense of their position (Kahane & Auerbach, 1973). They are able to suppress most of the compensatory eye-movements, imbalance, and feelings of rotation (and nausea), that are normally induced by rotatory and caloric tests, even though these tests differ considerably in terms of motor commands and sensory input from actively pirouetting about an earth-vertical axis (McCabe, 1960). This resistance to the effects of motion is acquired; McCabe was able to chart the development of suppression of rotatory and caloric responses in skaters as they learned to spin.

Close examination of the reactions of dancers to passive rotation suggests that many <u>different</u> kinds of perceptual strategy or sensorimotor learning may mediate their resistance to its effects. For example, all dancers learn the technique of "spotting", which consists of breaking up the constant rotation into shorter bursts of motion by keeping the head still for most of the turn and then whipping it around. This technique also requires learning to attend to useful visual information by means of "fixation", which simply involves staring at a stationary object in order to prevent reflexive eye-movements and provide a stable reference point for orientation. Fixation is a strategy which many people report that they spontaneously use to cope with attacks of vertigo (Austin, 1992). However, even when such techniques are prohibited, dancers

tend to be more resistant than normal to the effects of rotation, but they each seem to develop differing kinds of resistance. For example, some can suppress the compensatory eye-movements almost completely even in the dark, when optic fixation is not possible, while others show a normal, vigorous pattern of eye-movements in response to rotation (Osterhammel et al., 1968). Nevertheless, the two essential adaptive responses to rotation that they all share are that following a spin they can balance well, and feel no dizziness at all.

The phenomenon of partial generalisation of adaptation is, to some extent, already exploited to the benefit of vertiginous patients in the form of exercise-based rehabilitation, which encourages patients to engage in a subset of all possible eye, head, and body movements in order to develop sensorimotor coordination anew. The rationale for this form of rehabilitation is hence very similar to that inspiring motion sickness prevention programmes for aviators, based on a limited range of activities and motions. Some more sophisticated rehabilitation programmes are also starting to address the situation-specific problems which may be caused by particular perceptual and motor strategies (for a more extensive discussion, see Chapter 6). In view of the partial dissociation between responses in the laboratory and in the field observed in motion sickness, it seems reasonable to suppose that rehabilitation should also include practice in orienting in the situations causing disorientation in everyday life -- in the same way that, in the treatment of chronically sick aircrew, adaptation to provocative motions in the laboratory is routinely supplemented with graded exposure to actual flight (Stott & Bagshaw, 1984). In addition, the resistance to disorientation seen in people such as dancers and gymnasts suggests that by regularly undertaking difficult balancing tasks it may be possible to develop a degree of valuable perceptual-motor "fitness" or skill, in the same way that aerobic exercise can help to maintain optimal cardiovascular functioning.

Since it would appear that the achievement of coordinated orientation and balance can be considered an acquired perceptual-motor skill, it is interesting to examine the similarities and differences in the way in that children first develop skilled coordination, and the manner in which, following vestibular dysfunction, the adult is obliged to relearn these skills and capabilities. In the past, when humans were obliged to hunt for meat, run for safety, and stoop or climb to obtain roots, fruit, water and shelter, the inescapable activities of daily living would probably have been sufficient to ensure rapid and thorough compensation following a balance system disorder. However, in modern society the conditions for perceptual-motor learning may be less favourable for adults than for children, who exhibit an attraction to disorienting activities which contrasts with the marked aversion to activities provoking dizziness displayed by most vertiginous adults. Children seem naturally inclined to explore -- in other words, to test the limits of their environment and their knowledge. Evidence for this, in terms of learning about orientation, can be provided by simple observation. Toddlers delight in being spun, tossed or turned upside down, older children go out of their way to balance on high walls, perform handstands and somersaults, and ride on terrifying helter-skelters. Social structures strongly support these activities; every playground incorporates swings and roundabouts, and gymnastics is a part of the formal educational curriculum. The example set by both parents and peers encourages persistence despite initial fears, or indeed motion sickness; these are viewed simply as a natural phase to be overcome, rather than an insuperable obstacle. In

consequence, the child passes beyond the initial stage of disorientation, and acquires the perceptual schemata which are required in order to appropriately utilise the information pertaining to each special environment, and the action schemata which support skilled and coordinated activity within them.

Adults are much less likely to seek out these types of learning experience, and have limited access to situations and social roles which permit exploration of the boundaries of orientation. Any adult spotted swinging around a lamp-post or walking precariously along a narrow wall would be considered juvenile or affected, if not actually mentally disordered. The most plausible role model for the vertiginous individual to adopt is that of a partial invalid, who would be considered foolhardy to persist in activities that apparently exacerbated a medical condition. Moreover, the safe and structured learning situations of the child are not a natural part of the environment of the adult, who may have to struggle to master disorientation while driving, negotiating a business deal, or clambering around scaffolding with no safety harness. To an adult, disorientation in a certain environment or during a particular activity is therefore not perceived as a learning phase, but an unnatural and embarrassing sign of disability. These factors help to explain why an adult may rapidly come to perceive activities or environments which provoke disorientation simply as a source of physical and social discomfort, rather than a pleasurable opportunity to investigate the possibilities for coordination and balance. In a personal communication (Corcoran, 1985), a colleague confirmed that this entirely negative perception of disorientation may be a partly cultural phenomenon; when working in a remote village in Botswana, where motor vehicles were a rarity, he observed that riding on the back of his truck gave great pleasure to the local adults, even though (having developed no adaptation) they often became very sick!

Vertigo and the environment

Since orientation and balance can be affected as much by environmental factors as by the physical activities undertaken in these environments, people with vertigo or reduced vestibular function are abruptly made aware of properties of the natural environment which are scarcely noticed by those without orientation or coordination problems. Certain environments place special demands upon the orientation system which people with absent or distorted vestibular function may find difficult to meet. For example, walking up or down slopes alters the normal somatosensory information for postural control (based on the angle of the ankle), necessitating greater reliance on visual and vestibular information. Similarly, walking across rough terrain requires continual rapid corrections for the perturbations to balance encountered when stumbling over small holes or mounds, and these rapid adjustments are thought to be modulated partly by vestibular reflexes (Allum & Pfaltz, 1985; Allum et al., 1988). Dim light, darkness or the absence of visual structure close enough to aid in postural control (characterising heights and open spaces) increases dependence on the somatosensory and vestibular systems (Bles et al., 1980; Brandt et al., 1980). The difficulties caused by environmental conditions such as these can become overwhelming if more than one sensory system is simultaneously taxed; for example, walking across compliant surfaces (thick pile carpets or springy heather) in poor lighting. In addition, reduced vestibular function may promote

reliance on a postural strategy of swaying from the hips rather than the ankles, which minimises the need to detect and control head movement. This strategy may be advantageous in terms of providing a steady gaze and visual reference for orientation (since vestibular input is needed to maintain a stable head and eye position during perturbations to head position), but for mechanical reasons makes it difficult to balance on support surfaces that are narrow, slippery, or moving (Dichgans & Diener, 1989; Nashner et al., 1988).

Man-made environments can pose even greater problems, insofar as they extend the range of perceptually unusual situations that may be encountered. Many of these perceptually unusual situations can cause imbalance or motion sickness even in healthy people who have not habituated to them; for example, most forms of passive transport result in peculiar combinations of visual, vestibular and somatosensory information that could never be produced by any normal human movement. However, the poor coordination associated with balance system disorders can greatly enhance sensitivity to alterations in the usual patterning or availability of information for orientation, rendering the individual both more susceptible to travel sickness, and also susceptible to a much wider variety of perceptually confusing circumstances.

One of the most common results of this enhanced sensitivity to environmentally-induced disorientation is a phenomenon which can be termed "visual vertigo". The environments which often elicit feelings of disorientation include: traversing heights and open spaces; observing scrolling visual displays (e.g. looking through a microfiche or computer list); walking between the long shelves of supermarket aisle; looking at flickering lights or striped surfaces; standing on a bridge with moving water or traffic below; or travelling through a winding tunnel -- to name but a few. These situations are characterised principally by somewhat confusing or ambiguous visual information concerning self-motion, and an apparent discrepancy between the visual and other sources of information for orientation -- hence the use of the descriptor "visual vertigo". For example, vestibular signals indicating head movement are usually accompanied by movement of the visual field sweeping across the line of sight (see Chapter 1). However, when observing a scrolling screen or looking down on flowing water the movement of the visual field is not accompanied by any vestibular signal. Conversely, when travelling in a lift there is no visual information to indicate movement (as the lift cannot be seen to move), but the vestibular system registers the abrupt deceleration as the lift comes to a halt. People subject to visual vertigo are often particularly disoriented in circumstances which evoke unusual or vigorous vestibular signals in combination with the unusual pattern of visual information --for example, rapidly traversing hills, bumps and bends in a car. This pattern of situational provocation closely parallels that of motion sickness, and the perceptual factors determining how disorienting a situation will be are probably very similar, but the degree of perceptual complexity which provokes visual vertigo is less than that needed to trigger motion sickness in healthy people. Visual vertigo can be an isolated complaint, but many (though not all) people with diagnosed vestibular disorders also report heightened sensitivity to perceptually ambiguous situations.

Vertigo occurring in visually unusual or complex environments is a phenomenon which is poorly understood by patients, clinicians and researchers alike. It may therefore also be under-reported; clinicians are less likely to elicit

descriptions of these symptoms since they do not carry any clear diagnostic implications, while patients are often incompletely aware that their disorientation is provoked by specific situations, or may be cautious about speculating about the aetiology of their dizziness during a medical history. My personal impression, since developing an interest in "visual vertigo" and discussing it with a wide range of people, is that it may be more common than is generally appreciated, both within the population of patients suffering from vertigo and among people who have never been diagnosed as having any specific balance system deficiency. However, because of the apparently mysterious nature of this form of disorientation, the initial onset of visual vertigo is generally experienced as sudden, strange, inexplicable, and sometimes frightening:

> I went to the garden centre one day, and there was this huge stack of plastic pots, and somebody had tapped them and they were swaying like this [gestures from side to side] -- the next thing I knew, I was swaying almost along with the pots!
>
> I had to come down a long, long escalator, [suddenly] I felt dreadful -- I felt I was going to go tumbling all down the stairs and there was nothing I could do about it. I clung on to the escalator for dear life. Once I got to the bottom I continued my journey and tried to forget all about it. But what it did to me was it instilled an awful fear of having to face one of those long escalators and I have a son who lives in London with a baby and there have been times when I should have been able to go -- I haven't told anybody but I feel so frightened of these escalators that it puts me off even going to London.

The woman who provided the preceding account had never visited her son in the ten years since this incident, and had not explained to her son or husband why this was. However, in all other respects her attitude to the problem was very positive and practical; she deliberately practised riding on small escalators in shops, and taught herself to reduce her disorientation by fixating on the side of the escalator. She had also found that symptoms could be caused by traffic going by as she crossed a road, heights, and being surrounded by tall buildings, and she had experienced some minor spontaneous attacks of vertigo (and a gradual onset hearing loss and tinnitus). Her method of coping with the dizziness was to sit down or grab for support, breathe deeply, and wait for it to subside. She wasn't sure exactly what caused her symptoms, as their appearance was quite unpredictable, and had never sought medical advice since she was "... basically a believer in trying to live with what you've got -- I fight it myself if I can."

The account given by this woman does not suggest a neurotic or weak person, and yet the fear which accompanies visual vertigo is often attributed to personality characteristics. Brandt (1990) has described a common syndrome which he classifies as "phobic postural vertigo", which combines vertigo provoked by environments with relatively complex or unusual combinations of multisensory information for orientation (such as driving, or walking over bridges, through large shops, or down stairs) with symptoms of panic, anxiety and hyperventilation. Brandt suggests that the syndrome is caused by a transient misperception of orientation information caused by anxious introspection in

people with an obsessive or hysterical personality, but presents only speculative and anecdotal evidence in support of his hypothesis. In contrast, several psychiatrists have proposed that fear and disorientation caused specifically by disorienting environments is likely to have an organic neurophysiological basis (Blythe & McGlown, 1982; Jacob et al., 1989; Marks, 1981). In order to discriminate general anxieties and phobias from discomfort experienced only in situations characterised by unusual or ambiguous perceptual conditions, Jacob et al. (1989) employed a questionnaire to measure what they call "space and motion phobia". The questionnaire asked about responses to activities or situations potentially disorienting to those with balance difficulties, and for each of these included a "validity" item consisting of a corresponding situation less likely to be disorienting. For example, the effects of a moving elevator were compared with those of the less disorienting (but equally claustrophobic) environment of a stationary elevator. Jacob and colleagues examined patients with a diagnosis of panic disorder and symptoms of imbalance during or between attacks, or of giddiness in-between attacks. They found that the items likely to disturb people with orientation system deficiencies were endorsed much more often by these "panic" patients than were the validity items. They also found that the incidence of some (usually minor) abnormality on vestibular testing among the panic patients was twice that found in a group of healthy control subjects (Jacob, 1988). Levinson (1989) also reports a high incidence of abnormal neuro-otological test results in patients referred to a psychiatric department because of fears or "phobias" relating to heights, open spaces, darkness, crowds, and various forms of travel and motion.

A similar debate has been conducted regarding disorientation experienced chiefly when driving. The label "motorist's vestibular disorientation syndrome" was used by Page & Gresty (1985) to describe a rather specific constellation of symptoms associated with driving in particular environments: i.e. an illusory perception of vehicle motion occurring mainly when descending or turning, especially when the availability of visual information outside the vehicle is limited, such as in flat, open country, or when going over the brow of a hill. These authors found minor abnormalities on neuro-otological testing in patients with this form of disorientation, and suggested that it might be due to a failure to compensate fully for a sensory dysfunction. In contrast, Baloh and Honrubia (1990) attribute the same symptoms to "psychophysiologic dizziness" associated with psychiatric illness, owing to the ambiguity of neuro-otological findings and the observation that many such patients develop a profound fear of driving. However, the wariness of demanding orientation tasks and environments which is often characterised as phobia may be quite rational, as is evident from the following account given by a person initially diagnosed by her doctor as agoraphobic, but later found to have Meniere's disease:

> No way could I keep my balance or feel confident just to walk along the path, you know, that was the awful bit. I was sort of wobbling around all over the place, my balance was awful, and I was sort of walking along by the fence or something like that, keeping onto the fence. I can remember going out and sort of fixing my eyes on the lamp post and going from one lamp post to the other lamp post ... I tripped, and because my balance wasn't good I fell, and I fell on my head and I had eleven stitches

> over my eye, and broken glasses, and damaged my arm, and all sorts of things.

A plausible explanation for the phenomenon of visual vertigo is that individuals with distorted or reduced vestibular function may become dependent upon the visual system for postural stabilisation (Black & Nashner, 1984b; Keshner & Allum, 1986). This renders them vulnerable in situations characterised by sparse or ambiguous visual or somatosensory information, or when rapid correction for momentary imbalance is required. The perceptual strategy of relying on visual information for orientation in preference to vestibular is logical during and shortly after vestibular dysfunction, when the signals from the vestibular system are indeed unreliable; the strategy only becomes maladaptive if adhered to after changes in vestibular function have ceased, and in situations where visual information is unavailable or unhelpful. Evidence in support of this explanation was provided by a longitudinal study of patients undergoing surgery to destroy unilateral vestibular function; immediately after the operation, half of these people developed an abnormal sensitivity to visual information, which disappeared in every case over a period of 100 days, as compensation for the vestibular imbalance caused by the operation progressed (Black et al., 1989).

Descriptions of visual vertigo generally highlight the apparently vague, inexplicable and unpredictable nature of the phenomenon, which seems to be a major cause of its association with anxiety in the minds of clinicians and patients alike:

> Coming on the station, I walked through the station and it really bothered me -- the height, the people moving and something about it, maybe the light. Light affects me, when I walk quickly out of one light to another -- it seems to affect me, whether it is my mind or not I don't know ... going through different lights, if I am prepared -- I go through two tunnels on the M25 and that affects me, but I get prepared. I know what is going to come out at the other end and it doesn't bother me now, but it did at first because I was driving along and I wasn't really thinking about it.

An understanding of the perceptual causes of visual vertigo could therefore help sufferers to predict and cope with their disorientation, which might therefore appear less strange and capricious. Many people do eventually develop a partial awareness of the triggers for their vertigo, as shown by the following explanation for the sensations experienced when riding in a chair lift:

> Funnily enough, I am alright going up, I can do things going up; I can go up an escalator and perhaps go up a slope, it is just the coming down part. I have to work round not being able to go down an escalator. I have had to choose a route that I can get home without having to go down an escalator, which is inconvenient, very inconvenient. So we get in [the chair lift] and we are going up and it stops halfway and it is hundreds of feet up, and [her companion] says "Look, isn't it lovely" and I can't look -- he tells me what it is like which, is fine. When we got to

> the top he asked me how I felt and I said "That was not bad ... Tell you what, I will ride down". Well, we got in, and it was fine until it started to swing out, and the actual swinging out movement ... I tensed up obviously, my hands were sweating like crazy, and I tolerated it, but I was glad to get off.

This woman accurately notes that it was the combination of downward travel, the added vestibular stimulus of "swinging out", and perhaps her anxiety, that induced her symptoms, but was (understandably) unable to identify the precise perceptual reason why descending should be more disorienting than ascending. In fact, perceptual explanations can be provided for most of the phenomena described by people with visual vertigo. Since disorientation can be caused by the absence of stable visual structures close enough to be used to monitor orientation and control balance, descending is most problematic, as the stable visual structures of the ground immediately above fill the visual field when ascending a slope, but when descending one looks further into the distance below. Looking at the sides of an escalator when descending is therefore not helpful for controlling balance, since they are moving relative to the step on which one is balancing (although fixating on the hand-rail which moves with the step could possibly be effective); however, practising looking at the moving sides while balancing on the step may be an excellent way of learning to reduce dependence upon visual information for orientation (see Chapter 6).

As in the case of movement-provoked vertigo, the short-term strategies used to prevent disorientation can actually retard long-term compensation. Together with avoidance of disorienting environments, one of the most common strategies adopted is fixation on stable objects:

> I try, when I'm at home, to keep my vision fixed on something solid. You don't watch butterflies or stuff like that 'cause if you watch it flitting around it makes you go all queasy -- you have to try and keep yourself fixed on something stable all the time.

Indeed, Hood (1970) has noted that people with longstanding vertigo and anxiety often become adept at using fixation to suppress the eye-movements induced by vestibular stimulation. However, it is this very reliance upon a stable visual environment that renders these individuals vulnerable to visual vertigo in situations where fixation is impossible or inappropriate.

Since vertigo and imbalance arises partly as a result of the interaction between the characteristics of the environment and the particular perceptual-motor difficulties and strategies of the individual, environments can differ greatly in terms of the hazards they present and the handicap they impose. Many people with vertigo are troubled principally by its effects on their ability to cope with a specific set of circumstances which, although discrete and relatively uncommon, are nevertheless central to their way of life. Often these circumstances are occupational; a sailor must have good balance, a construction worker must be safe at heights, a physical education teacher must be able to move freely, those offering mobile services must be able to drive, factory-workers must cope with potentially dangerous machinery, and computer operators must tolerate scrolling and flickering visual field motion. Sometimes the home situation may be a source of problems -- for example, living in a tower

block brings difficulties with lifts or stairs to prominence, while living in a remote rural area may make driving a virtual necessity. Hence, the disability and handicap experienced by individuals with vertigo is determined crucially by their local and occupational environments; a bank manager living in a quiet town might be able to adapt with relative ease to a degree of vertigo which would completely disrupt the life of a travelling salesperson based in London.

Changes in the relationship with the environment at the perceptual-motor level entail fundamental phenomenological changes in the way in which the environment is perceived. In her autobiographical analysis of the impact of multiple sclerosis, Toombs (1992) comments that:

> The meaning afforded by sensory-motor experience is a direct response to the world and is prior to any act of reflection or conceptualization ... Locations and perceptions are immediately apprehended in relation to my body placement without being made explicit. Beneath objective space is a primitive spatiality of the body. (pp. 54-5)

She notes that illness can transform spatial relations: locations formerly perceived as "near" become unattainably distant, while disability may even undermine the upright posture which distinguishes every mature adult capable of "standing on his/her own two feet". The unsettling nature of these alterations in the relationship to the environment are vividly conveyed by the following accounts of the effects of vertigo:

> We've got an en-suite loo, and I'm lying in the bed feeling I want to be sick and go to the loo, and I mean I couldn't even walk from here to there to be sick in the loo, I had to go on all fours to be able to just make it to that door -- that was to me the horrendous side of it.

> You feel that the world is no longer stable and that it's -- I would imagine that it's a similar sort of feeling as if you've been through a very serious earthquake.

> You're not sure where your feet are going, and if you come to a bit of pavement that's just a little bit sloping or something, it tips your balance that much and you just go over. I found I was a bit unsteady walking, and then when I fell into the bushes on the way to work I realised things weren't -- you know. I got stuck in a bush, and I didn't know what to do, I was going further down 'cause they were sort of flimsy bushes and they were just breaking off (there's still a hole up there, even now), so I had to get onto the floor and then sort of crawl, crawl out backwards and stand up again.

Hence, in the same way that vertigo can result simultaneously in disability and changes in the physical self-image of sufferers (detailed in the first section of this chapter), disorientation and imbalance may also lead to profound changes in the actual and perceived nature and possibilities of the physical environment.

Van den Berg (1987) illustrates this phenomenon in normal life with the example of fatigue. Tiredness not only makes distances seem longer and steps steeper to the exhausted individual; these distances and heights are actually more difficult to scale than when well-rested, and may eventually even become impassable. Similarly, to the individual with vertigo an invitation to embark on a cross-country walk at dusk no longer promises simply a pleasant recreation, but also threatens stumbling and effort owing to the difficulty of maintaining balance on uneven ground with diminishing visual information, while a trip to the city offers not only the attractions of shopping, but also the hazards of travel, crowds, busy streets, escalators and flashing lights, all of which may provoke or exacerbate disorientation.

The purpose of this chapter was to explain how vertigo affects and is affected by physical capabilities and activities, and the way these interact with characteristics of the environment. However, it is clear that the physical parameters of the experience of vertigo are intimately linked to the subjective and psychosocial aspects of the experience: the apparently inexplicable disorientation induced by visually complex man-made environments promotes anxiety and phobia, while the physical and social context of modern society offers limited opportunities for perceptual re-learning; disability may give an impression of lack of spontaneity and premature aging, while fear of the consequences of physical movement can retard compensation. The following chapter consequently explores in greater detail the way in which cognitive and emotional processes -- thoughts, perceptions and feelings -- influence and are shaped by the problem of dizziness and imbalance.