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Author: David Vender

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Reid's Discovery of the Sense of Balance

David Vender

When we speak about the senses we usually mean the five traditional senses, but even a slight acquaintance with the scientific research on sense perception tells us that the simplest questions about the senses are currently open questions.

What is here meant by the simplest questions are how many we have and how they should be counted. If there are no good answers to these basic questions, or at least a fairly broad agreement on how to proceed, then we don't really even know what a sense is.

Until recently there was little concern about the senses in philosophical discussions and when they needed to be mentioned the old list of five was offered or, more simply, vision was enlisted as a paradigm of all perceiving and the problems of vision tended to be discussed as if everything said applied across the whole sensory range. This is easily checked and there is no need to go into examples. It is fair to say that this substitution of vision for perception is not always incautious or misleading, but it has been very widespread.

All this is now changing. Debates are emerging about the counting problem and the problem of the individuation of sense modalities, which is the closely related problem of separating the senses.[1]

There are various currents in these debates and it would take some time to go into even the main issues but the aim here is to point out the danger of missing an important opportunity by neglecting to pay enough attention to the most remarkable, the most fundamental sense. This is the sense of balance.

Two things should be made clear. Firstly, what Thomas Reid can tell us about balance and, secondly, how important and astounding balance is. Reid is not generally cited as a contributor to our understanding of balance. Perhaps if one is looking at the senses from a physiological or psychological perspective then his remarks are a bit thin, but looking at what he said in the context of the philosophy of perception is very worthwhile indeed.

So in outline we first look at the senses and the discovery of balance, then review what Reid said about balance, how it fits into the historical picture

[1] See F. Macpherson (ed.), *The Senses: Classical and Contemporary Readings* (New York, 2011).

and what the crucial points for us now are. After that it is best to catch up with some of the comments about balance in the current debate about the senses. There are some peculiar things said about it and Reid can be asked to help us sort out some of the muddles. Finally, a suggestion or hint from Reid will be taken up in order to show that the point about balance being the most fundamental sense – maybe it is better to say that it is foundational for all perception – is not just grandstanding. This will be illustrated by a few empirical results from the scientists looking at balance.

The Discovery of Balance

We all know what balance is. If you lose your balance you fall over. If you drink too much wine you get wobbly and walking becomes a bit precarious. There are also some terrible afflictions which cause the sufferer to be incapable of orderly movements or even make them unable to stay stable. But is balance really a sense?

Asking this question immediately complicates matters but speaking generally we might expect that to count as a sense there should (a) be an identifiable organ or set of organs, (b) when this is working properly we use it to obtain some specific information about the physical world, and (c) that our possession of this information is not merely inferred indirectly but that it actually informs or at least plays into our direct experience of the world. These may not be separately necessary and jointly sufficient criteria and each can be debated but it is a reasonable starting point.

A question now arises. If balance is indeed as important as has just been said, why has it not been counted among the senses? Why have humans walking and falling over for millennia and developing all sorts of cultures failed to notice it? Three reasons which reinforce each other can be suggested.

Firstly, starting with experience, it is a fact that when everything is going well there is little to be distracted by in our bodily balance. We notice when we are about to topple over, we get miserable when seasick or suffering from vertigo, but generally speaking balance is a pretty quiet sense. If we feel anything while going about daily routines then we hardly notice it and how it plays into experience is more subtle than seeing colours or hearing sounds.

Secondly, the organs are well hidden. It is not even clear where they might be. Most of the parts of the body have some role in maintaining posture so it is not obvious where one should look for organs – even if, like touch, it is

a distributed sense with receptors all over the body. As it happens there is a localised set of relevant organs but scientists now rarely speak of a sense of balance since that needs several co-operating systems. Arms and legs and feet and muscles and joints are all needed to maintain posture, but the keystone holding this elaborate frame up is not in the muscles or joints. A most important piece of the puzzle is the vestibular apparatus hiding in a thick piece of bone behind each ear.

It is a complicated organ which transduces the direction of the resultant force from gravity and linear acceleration, as well as rotations around the three orthogonal axes in space. Since it is so close to the inner ear there might be a temptation to think that it has something to do with hearing. Even if that mistake is avoided, one needs to know quite a bit of physics to understand how it works. It is not too much to say that before the physics of Galileo and Newton it would have been a struggle to unravel the mystery of its basic workings.

Thirdly, all the important functions and malfunctions of the vestibular apparatus seem to point to this organ as something which is important to the individual, much as the heart or liver might be. To count as a sense for the naive understanding the organ must be pointed outward, it must tell us about external objects. Pain and hunger are private and not counted along with the five. Similarly, motion sickness and even the ordinary feel of walking have more to do with individual vigour, fitness and disease than with sensory perception as traditionally understood.

These three reasons seem sufficient for not counting balance as a sense. As it happens the naive understanding is quite wrong in trying to make a neat division between our bodily sensations and what the Aristotelians used to call the five external senses, but to see this one needs to look at how the role of the vestibular apparatus was clarified.

Among the important names usually associated with the history of vestibular research are Ernst Mach, whose philosophical fame rests largely on psychophysics and his radical relativism, Jean Pierre Flourens, the famous physiologist who described the organs, and Jan Purkyně, who examined vertigo after rotation.[2] These are all figures from the nineteenth century but Nicholas Wade from the University of Dundee has looked at the early history and there

[2] Some of the history is covered in J. E. Hawkins and J. Schacht, 'Sketches of Otohistory Part 8: The Emergence of Vestibular Science', *Audiology and Neurotology*, 10 (2005), 185–190, and N. J. Wade, 'The Search for a Sixth Sense: The Cases for Vestibular, Muscle, and Temperature Senses', *Journal of the History of the Neurosciences*, 12 (2003), 175–202.

is an unsung hero there.[3] William Charles Wells was a contemporary of Reid and he deserves the lion's share of the credit for the early experimental work on how rotation affects our vision.

The point to notice about much of this early work connected to the vestibular organs is that it is not actually about the sense of balance. It is really about vision and how our vision depends on movements and accelerations. The subjects of the experiments on vertigo and nystagmus following rotation were either strapped to a chair and spun about or simply turned till they got dizzy, as children like to do.

If our main interest is in normal healthy balance then these performances are only a small part of the story. They tell us a lot about the interactions and conflicts between vestibular function and the vision system, but little of direct significance about balance and especially agency. To understand the basics of balance, it is better to see what Reid had to say.

Reid's Remarks on Balance

Reid's explicit remarks on balance occur in a late essay on voluntary motion. This essay appears in the collection called *Thomas Reid on the Animate Creation* edited by Paul Wood.[4] The essay is called 'Of Muscular Motion in the Human Body' and it was read before the Glasgow Literary Society in 1795.[5] By the way, Wells published his *Essay on Single Vision With Two Eyes* with a description of the experiments on vertigo in an appendix in 1792.[6] Wells of course knew of Reid and made some comment on Reid's ideas on vision from the *Inquiry*.[7]

This is what Reid said on balance:

> This Power we have of perceiving the ballance of our Body is so like to our other external Senses, that it might very justly have been accounted

[3] See N. J. Wade, 'William Charles Wells (1757–1817) and Vestibular Research Before Purkinje', *Journal of Vestibular Research*, 10 (2000), 127–137, and N. J. Wade, *Destined for Distinguished Oblivion: The Scientific Vision of William Charles Wells (1757–1817)* (New York, 2003).

[4] P. Wood (ed.), *Thomas Reid on the Animate Creation* (Edinburgh, 1995).

[5] Ibid., 28.

[6] Wade (2000), 130–1.

[7] Giovanni Grandi has pointed out to the author that among Reid's manuscripts there are notes showing that Reid read Wells' essay in June 1792. There are no comments on the appendix.

> a distinct Sense, if it had been so much reflected upon as to require a Name.
>
> In each of the external Senses, there is an Impression made upon the Body or on some part of it, which by our constitution produces a certain Sensation of the Mind, and that Sensation is by our Constitution accompanied with the Perception of something external.[8]

He also remarked on the importance and excellence of this sense:

> When we observe with what ease, and Grace those Motions are performed by those who are expert, and compare them with the Laws of Motion, we must be convinced that this Sense by which we perceive the least deviation of the Body from its Ballance, may by Use be brought to a degree of Accuracy which is hardly to be observed in any of our other Senses.[9]

Contained in these remarks are tremendous insights about the senses, especially if we pay attention to the context, which is a discussion of voluntary movements. Here is just a little more:

> This sense of Ballance may be seen in a Child of two or three Months old. If sitting upon ones knee he begins to tumble, he immediately starts & endeavours to recover himself. But it is greatly improved by Use, in every Employment that requires its exercise … This sense of our Ballance is produced not onely by the impression made by the power of gravity but by any other Force which endangers the Ballance.[10]

Reid does make some remarks on vision in the same essay, but these are mainly to do with directing the eyes by means of the antagonist muscles – so he speaks of a balance in the nervous power of those muscles – rather than the cross modal effects studied by those investigating vertigo and imposed

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[8] Wood (1995), 110. Reid is here explicitly affirming that the workings of balance are consistent with his epistemological scheme and his distinction between sensation and perception.

[9] Ibid., 111.

[10] Ibid., 111.

accelerations. He is primarily concerned with how active agents use the muscles and notes that:

> There are however many voluntary Motions in which some previous Perception of the Understanding is necessary to direct us to the Motion which the occasion requires.[11]

Not only must we sense how muscles move, muscular exertion is the default state:

> Although all voluntary Motion is performed by the Contraction of Muscles, we must not from that conclude that when no Motion is willed, the Muscles are inactive. *The Exertion of Muscles is no less necessary to rest than to Motion. In every position of the Body excepting perhaps that of lying prone* The reason of this is that there are so many Articulations in the Limbs, & in the Spine & Neck and these in a living Body have such Lubricity to facilitate their Motions that without the Exertion of Muscles, it would sink down to the ground like a Chain of many links. So we see a Man does if he is struck dead or deprived of all power of Muscular Motion in an instant.[12]

Wells, and Reid's Main Points

As already mentioned, a few years before Reid's remarks William Charles Wells published an essay on vision. In an appendix called *On Visible Position, and Visible Motion* Wells speaks about balance. He starts by noting that:

> In the estimates we make by sight of the situation of external objects, we have always some secret reference to the position of our own bodies, with respect to the plane of the horizon; and from this cause, we often judge such to be at rest, whose relative places to us are continually changing; and others to be in motion, though they may constantly preserve, in regard to us, the same distance and direction.[13]

[11] Ibid., 110.

[12] Ibid., 112, emphasis original.

[13] W. C. Wells, *Two Essays: One Upon Single Vision with Two Eyes; The Other on Dew* (Edinburgh,1818), 69.

The concern here is with judgment of visible motions. Wells talks explicitly about bodily balance a little further on, saying:

> What is there within us, to indicate these positions of the body? To me it appears evident, that since they are occasioned and preserved by combinations of the actions of various voluntary muscles, some feeling must attend every such combination, which suggests, from experience perhaps, the particular position produced by it. But in almost all the positions of the body, the chief part of our muscular efforts is directed toward sustaining it against the influence of its own gravity. Each position, therefore, in which this takes place, must be attended with a feeling, which serves to indicate its relation to the horizontal plane of the earth.[14]

Wells then immediately considers how it is that we see objects to be still despite irregular motions of the body such as are experienced on a ship rolling and pitching. The point is that Wells is really interested in visible position and motion and how perception of these relates to bodily motions. Reid in his essay is not particularly interested in the perceptions of sight but in the control of bodily movements themselves.

Three of Reid's crucial points are:

1) Voluntary movements and efforts maintain balance and posture. The implication here is that this sense is active in that we participate as agents in generating the sensations felt. The perceiver and the actor are one and the same and if we wish to entertain a passive model of perception such as placing the perceiver in a Cartesian theatre then we have to allow them to get onto the stage because without their activity and participation the show simply does not go on.
2) This sense has its own sensations. Without getting into the details of Reid's views on sensations two remarks are appropriate. Firstly, these sensations are bodily sensations associated with muscles and Reid did associate balance closely with muscular sensations. Secondly, these sensations are normally subliminal unless we are in imminent danger of falling or are pushed and need to act decisively to restore our balance. As Reid might have said, we normally pass over these sensations unnoticed and attend to our other perceptions as we pursue our goals. That does

[14] Ibid., 70.

not mean that we are not doing anything in keeping balance. In fact we are always acting and the sensations informing us of posture and movement are always present.

3) There is evidence of development. Watching infants and young children rather than normal adult functioning is helpful. Infants spend much of their time trying to orient themselves and to control their movements. The triumph of this development is getting mobile, particularly in standing up and walking. Even later we can become more skilled in performing various motions.

There is no need to play Reid off against Wells in a competition on these points. Wells made closely related remarks. Here is an example:

> Should the necessity of supporting the body against its gravity, by the actions of our voluntary muscles, be suspended in whole, or in part, our judgments of the situation of objects, with respect to the horizon, must become irregular and uncertain, notwithstanding any general habit we may have acquired from experience.[15]

The main reason why what Reid tells us is exceptional comes from a fourth point and that is his remark that we should compare our achievements to the Laws of Motion and count the sense of balance as an additional sense. That is a very fine suggestion because it challenges our ideas about what a sense is.

Why has balance not been counted as a sense? The simple answer to this, as suggested earlier, is that the traditional count separates the perceiver from the world. Information about our own body, however it is acquired, is separated from perception of external objects and their qualities and properties. The count is conservative in that only those perceptions for which it seems easy to draw the line between the objects in the world and ourselves are given to our senses.[16] This separation is not easy for sensations of pain or of warmth and so we do not traditionally count senses of warmth and pain.

Motions, as it happens, also seem to separate easily into motions of our body and motions of external objects perceived mainly by sight. But we do not traditionally count a sense of motion because perception of the motions of objects is already attributed to the sense of sight and when we feel motion by

[15] Ibid., 73.

[16] This conservatism is now still reflected in calling bodily sensations *private* as, for example, Armstrong does when separating the perceiver from the surrounding world. See D. M. Armstrong, *A Materialist Theory of Mind* (London, 1968), 307.

touch then it is not separate from the motion of our body and the boundary between active and passive moving is inconstant and dependent on attentive involvement. Applying then the conservative approach it can be said that feeling movements by touching objects is more like interacting with hot and cold objects than it is like watching passively the movements of objects in space. Hence a sense of bodily motions was not traditionally counted.

This naive separation of the senses from the perception of self evidently did not impress Reid who took the direction of gravity to be external even if we do come to know it primarily by way of sensations within our body. It is interesting that where Reid speaks of 'external' Wells writes about 'sustaining [the body] against the influence of its own gravity'.[17] In any case the naive separation does not survive critical reflection. When we look at the laws of motion, even in the context of Galilean relativity, then the separation of self-motion from motion of objects is not simple after all. It is wholly ambiguous. Even locating stationary objects in space inevitably implicates the perceiver in a relation, just as sticking a cold hand into warm water tells us about the interaction rather than about the absolute temperature of the water.

In one way there does seem to be a natural division of movements. This is the division between moving and being moved. As just mentioned this is complicated by the fact that motion is not always attended to, especially in habitual movements or the skilled movements that we are inclined to call 'effortless', and deliberate movement brings in further complications because we cannot confine ourselves to kinematic descriptions – moving body parts deliberately is always dominated by force and friction, resistance and strain. These are the quantities of dynamical descriptions and dealing with them explicitly can only be avoided by resorting to vague discussions of 'motion' in the abstract while hoping that an imprecision in describing the phenomena is inconsequential.

If the sensory separations involving motions are to be made systematic, everything is found to depend on accelerations and with those on efforts, muscular strains and voluntary movements. We are speaking not simply of spatial relations and movements of constant speed but about dynamics, with force, inertia, friction, acceleration, velocity, distance and duration all involved. It is important to notice this: moving the parts of our body is more a question of directed effort and acceleration than it is of translation, and the physics of those movements feels more Aristotelian than Newtonian.

[17] Wells (1818), 70.

Before saying a little more about dynamics and how the sense of balance provides the clue that is needed to understand how the separation between the perceiver and the world implicit in the tradition is unworkable, it is instructive to glance at the modern philosophical debate on the individuation of the senses.

The Current Debate

In looking at the recent discussion of the senses in philosophy it is apparent that the main concern is with how one should reconcile the discoveries of science, particularly physiology, psychology and more recently neurobiology, with traditional philosophical arguments about perception. In particular, the question is how the senses should be counted and what the meaning of the tradition of five is. An important early contribution is from Grice who considered specific criteria for counting and the search for and analysis of criteria has been central to the continuing debate.[18] Brian Keeley has recently suggested that philosophers should follow the lead of neuroethologists – the scientists who study the sensory endowments of exotic species such as the star-nosed mole and the pit viper. Keeley's main point is that sensations can be safely ignored when we differentiate the senses or try to decide what is or is not a sense.[19]

This idea that sensations do not tell us anything useful about our senses is not confined to materialists such as Keeley and it would seem to be a difficult thesis to defend against common sense views. Reid has a lot say which is relevant, but the present topic is not the role of sensations in general but the importance of the sense of balance so what has recently been said specifically about balance needs to be looked at. However, one important consideration must be kept in mind.

Reid and Wells worked far too early to have known the various functions of the vestibular apparatus. Nowadays everyone who discusses orientation and balance must be aware of its importance, but when we consider what Reid wrote he was evidently talking about a multisensory modality in what he called the sense of balance. Putting this negatively, he still had it mixed up with the muscle sense. Putting it more positively, he was considering an endowment in which both proprioception and vestibular functioning play a role. The relevant

[18] H. P. Grice, 'Some Remarks about the Senses', reprinted in R. J. Butler (ed.) *Analytical Philosophy, First Series* (Oxford, 1966), 133–53.

[19] B. L. Keeley, 'Making Sense of the Senses: Individuating Modalities in Humans and Other Animals', *The Journal of Philosophy*, 99 (2002), 5–28.

sensations are what I would like to call compound or complex sensations. To give an example of what this means by using colour, what is sensed is not simply 'red' but that colour just over there which has just been noticed and may now be fading or changing hue and must certainly contrast with other colours in the field of view.

With this in mind it is important to notice two aspects of what is said about vestibular functioning at the present time. The first is that the vestibular apparatus provides no specific sensations.[20]

Now a sense without sensations would seem to have no place in Reid's epistemology, and it needs to be asked what the vestibular apparatus could do for us if it does not somehow contribute to our subjective experience. As it happens it is not difficult to see what an organ which transduces the direction of gravity and a set of organs which transduce angular accelerations in the three orthogonal directions of space can do. They provide direction and perspective. They do so by breaking the symmetry of purely relative spatial relations in fixing a dynamical 'downward' as well as the directed rotations around the up-down, front-back, and left-right axes of the head. Hence they give us a reference frame and even what might be called, in the context of dynamics, an 'absolute here'.

Directionality and place is thus potentially available for all sensations if this information is integrated with other sensations and feelings, giving them not just their relative 'thereness' but fixing the human frame with respect to the frame of reference of the Earth with its universally shared up and down, thus making it possible to gauge the locations and the relative motions of not just body parts but also external objects.

This role of the vestibular organs in giving directionality and a fixed reference to *all* sensations can be considered initially as a speculation. Before seeing where it leads there is the other important aspect of vestibular functioning to be noticed. It arises in discussions of how many senses we count and how our own activity in using the relevant organs contributes. Two examples will serve to illustrate the issue.

Firstly, Brian Keeley considers a suggestion made by Anthony Kenny and David Armstrong that part of what we mean by perceiving is the awareness of moving and using an organ to get information. Keeley writes:

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[20] D. E. Angelaki and K. E. Cullen, 'Vestibular System: The Many Facets of a Multimodal Sense', *Annual Review of Neuroscience*, 31 (2008), 125–50. F. A. Geldard also makes this remark in *The Human Senses* (New York, 1972), as does W. von Buddenbrock in *The Senses* (Ann Arbor, 1958).

> Armstrong proposes … that sense organs are bodily structures that we actively use to gain information about the world, as when we open and move our eyes to see or cock our head to hear. But he continues, this runs up against the problem that we do not actively move organs in all the putative cases of sense. For example, we do not do anything to gain vestibular information. It seems to be ever present (which might explain why Aristotle did not remark upon it). The use of an organ in active perception does not seem to be of help here.[21]

Armstrong in fact does not mention balance or the vestibular apparatus and does not seem to be interested in orientation in the relevant books dealing with bodily sensations, but from what Reid and indeed Wells have been telling us it is easy to see how mistaken Keeley's comment is. If we wish to collect vestibular information then it is actually what we do and do all the time that matters. If we simply lie down and make no effort then orientation can eventually be lost.[22] It is also *because* the collection of this information as part of our efforts is 'ever present' that allows it to serve as the basis for the intentionality of our voluntary movements. These are intentional in the sense that they have a goal and a desired direction. If we had no up-to-date knowledge of the direction to the objects which we wish to reach, there is no way we could reach out to them.

Since Keeley's advice is to ignore sensations entirely it is not surprising that he considers the 'awareness of organ use' criterion only to replace it with the idea that considering the anatomy, wiring and dedication to a function of the organs is enough. To see the view I am disputing actually espoused, we need to turn to John O'Dea who says that:

> It is an odd fact that some rather obvious senses were never included in the traditional five. The account I'm proposing can explain this, in the following simple way: that in these cases there is no *feeling* of using any sense organ at all. The most vivid examples of this are proprioception and the senses of balance. … with the sense of balance; you don't need visual, tactile, or any other cues to know which way the ground is.

[21] Keeley (2002), 13.

[22] This should not be taken to imply that relaxing or reducing the effects of gravity by immersion in a flotation tank will quickly lead to disorientation. The connections between attention, habit, action and stimulus are complex. Orientation, as well as proprioceptive knowledge of the extent and position of bodily parts, are in some ways remarkably robust but at the same time surprisingly fragile.

> But there is no part of the body that we're aware of using to find that information out. If my account is correct, it makes sense that these were never counted as sixth or seventh senses.[23]

It is always debatable just how much we are aware of, but by paying attention to what Reid said about our sense of balance we can see what is wrong here. It is closer to the truth to say that with the sense of balance it is every part of the body that we're aware of using to remain upright and keep oriented with respect to the vertical and our goal. Paying concentrated attention to the relevant sensations is quite another matter, but we find out which is the downward direction and are constantly reminded of it from the downward pull on our body and the efforts we need to make to resist falling to the ground.

The Foundations of Perception

It might seem that at least some of what has now been said is overstated. If we look at the psychological literature then it is clear that apart from a vestibular judgment of the vertical our vision also provides a reference and the two can even come into conflict. It is also well known that pilots should not fly 'by the seat of their pants': if they lose visual reference by flying through clouds they are liable to crash. Perhaps the vestibular apparatus or even balance is not essential after all.

Two clues to what is important, both mentioned by Reid, are relevant. We should not be considering abstractions such as extension and depth, or just one direction or a horizon alone; we should relate our performance to the Laws of Motion. As Reid understood these, this is Newtonian dynamics in which vector forces are taken to be real and the composition of forces determines how one should direct effort in moving and turning and so on. Also, we should consider how balance develops and how our directed actions allow us to acquire habits of perception. That habits are as important in seeing as they are in walking and moving was evident to Reid already in the *Inquiry* where he speaks of how infants learn to see objects:

> From the time that children begin to use their hands, nature directs them

[23] J. W. O'Dea, 'A Proprioceptive Account of the Sense Modalities' in Macpherson (ed.), *The Senses: Classical and Contemporary Readings*, 308, emphasis original.

> to handle every thing over and over, to look at it while they handle it, and to put it in various positions, and at various distances from the eye.[24]

He then continues to emphasize the importance of acquired perceptions and perceptual habits. So in brief we don't want vague talk of motion, nor the abstracting out of spatial relations such as extension, or of duration. We want to determine the precondition for actual purposive movement characteristic of an agent. Whether this be a response to a specific stimulus or the enacting of an imagined scenario, this motion is a from-to movement accomplished by an effort and not just a kind of passive drift or a senseless flailing about. The fundamental starting point here is not knowledge of space as an abstract room to move but knowledge of direction and acceleration.

It is essential to recognise that without direction and orientation we not only cannot move as we will, we also cannot see objects since the precondition for seeing something is to look at it and keep still or at least distinguish motion of the object from the motion of the observer, as Wells pointed out. This is the basis for identifying persistent individual objects rather than merely facing a confused play of colour. The perceiver can eventually acquire habits of seeing so that vision can compensate some acquired deficiencies of balance, but vestibular functioning is the key ingredient for developing spatially informative seeing, just as it is for goal directed movement. In linking balance closely to voluntary motions Reid is effectively granting the agent an ineliminable role in not just moving, but in perceiving. To be a bit provocative, perhaps one can say that balance is a precondition for physical agency and perceptual learning. If vestibular function has an important role in this then this set of organs must be in place before the development of perceptual habits can begin and vestibular information on the spatiotemporal structure and dynamic response of the physical world is then integrated into all these habits. These habits include what we ordinarily call seeing and hearing. These large claims can be illustrated by some recent research into vestibular functioning.

Firstly, all moving organisms which have something invested in going in a particular direction have some organ for determining the downward direction. These organs are some of the most ancient in evolutionary terms.[25] For an organism which is extended and has proprioceptive knowledge of bodily

[24] Thomas Reid, *An Inquiry into the Human Mind on the Principles of Common Sense* (Pennsylvania, 2000), 201.

[25] S. McCredie, *Balance, In Search of the Lost Sense* (New York, 2007), ch. 4.

position only one direction has to be fixed in relation to the environment for the organism to fix its own frame of reference and measure or compare positions and movements of objects. It is difficult to see how this might develop without a universal direction and a means of fixing it.

Secondly, as a recent review of vestibular functioning puts it:

> Unlike other senses, vestibular information in the central nervous system becomes immediately multisensory and multimodal. There is no overt, readily recognizable conscious sensation from these organs, yet vestibular signals contribute to a surprising range of brain functions, from the most automatic reflexes to spatial perception and motor coordination.[26]

Thirdly, as Daphne and Charles Maurer explain in their book on the cognitive development of infants:

> Of all the sensory systems, the vestibular system is the first to mature. The organs of balance in the inner ear are mature in shape and are partially innervated before eight weeks of gestation. By six months gestation they are not only mature in shape, they are also mature in size and are completely innervated – the only organs in the body to become adult during gestation.[27]

This, by the way, is the reason why newborns can already have spatial competencies – they acquired them in the womb. Fourthly, in specific comments on the sensations experienced by newborns the Maurers note that:

> Adults' sensations rarely spill from one sensory system into another, as the newborn's do. But a signal exception to this lies with our sensations of balance and sight, which work together so closely that if we close our eyes and pirouette, after opening them again, the world looks as if it is moving. In contrast, the newborn's sensations spill about throughout his brain from one system to another, because his brain lacks the adult's deep network of neural channels; and one set of these channels that is not mature is the set that links the vestibular and visual systems. So

[26] Angelaki and Cullen, 'Vestibular System: The Many Facets of a Multimodal Sense', 125.

[27] D. Maurer and C. Maurer, *The World of the Newborn* (New York, 1988), 161.

> the one place where adults are signally synesthetic, the newborn baby is not.[28]

What the baby is learning in perceptual learning is to integrate vestibular and bodily information with external stimulation by light and sound. So, far from separating itself from the environment, it is placing its body and integrating its sensory organs into the dynamic world. Fifthly and lastly, Patrick Wall has something fascinating to tell about balance in his book on pain. In talking about people who have suffered a stroke which has destroyed their inferior parietal cortex, he tells us that:

> If the stroke has occured on the right side of the brain, these people appear completely unaware of anything on the left side of their world. They appear blind and deaf to anything occurring on the left and, most bizarre of all, when shown their own left hand they deny that it is part of them … Now comes the really astounding fact. Italian doctors, whose results were confirmed by many others, discovered that stimulation of the vestibular system in the ear completely restored all sensation on the left side. It disappeared again as soon as the stimulation stopped.[29]

There is no perception of spatial relations in the world without the enabling role of the vestibular system in our sense of balance.

As already noted, neither Reid nor Wells were actually talking about the vestibular system. Wells in his experiments comes closer to investigating the rather direct link between eyesight and vestibular stimulation, but Reid was really talking about actively maintained bodily balance. Now there is at least one way in which it is right to say that we do not do anything with the vestibular organs when we collect the information needed to balance. The actual organs are beyond voluntary control. The same can be said of the olfactory receptors and even the ears. When we sniff or cock our head to hear we are not really moving the organ but merely orienting it or stimulating it indirectly.

This has important implications for placing the vestibular apparatus correctly into the sense of balance. Vestibular signals are not enough if what one wants to achieve is balance or if they wish to educate their eyes and ears

[28] Ibid., 164–5.

[29] P. Wall, *Pain: The Science of Suffering* (New York, 2000), 148–9.

about spatial relations and relative motions. To do any of that we actually have to use our muscles and exert effort. Fully functioning vestibular organs are not even essential for balance and once we achieve the upright posture vestibular information plays no part in maintaining it.[30] It may then well be asked what its main role is in the sense of balance and in perceiving.

The general answer is that the sense of balance involves vestibular, proprioceptive and tactile systems. The extent to which all these systems contribute and how malfunctions are compensated raises empirical rather than philosophical questions. What makes the vestibular organs special is that they provide that 'secret reference' directly to the head senses which we use to see and hear with. These are our most important senses for the detection of remote objects and the positioning of and control over the motions of the head are needed to begin perceptual learning with these head senses.[31]

But given all this it is nevertheless wrong to call the vestibular system a sense of balance for the simple reason that balance requires two participants. The best that the vestibular sense can do is to provide some of the information needed in this interaction, and the value of Reid's insight lies precisely in his placing the perceiver in the centre of the action of balancing.

Conclusion

Reid's comments on balance still have the potential to change how we think about our senses and how we draw the line between the active perceiver and the physical world. His remarks occur in the context of a broad consideration of voluntary motion and they allow us to see balance as a modality which involves the whole body in exploratory activity. Without this sense our agency cannot come to expression in purposeful behaviour and the exploring needed for perceptual learning cannot begin.

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[30] I. P. Howard and W. B. Templeton, *Human Spatial Orientation* (London, 1966), 255.

[31] Even if the vestibular sense is not essential in maintaining the normal stance, it becomes more important for keeping the head still and oriented while running. There is good reason to believe that this has until recently had significant survival value, see McCredie, *Balance, In Search of the Lost Sense*, 107–15. Large and sensitive vestibular organs are a measure of agility and they facilitate skilled jumping and turning, not to mention accurate throwing. On the other hand, impaired vestibular functioning can be more easily compensated in humans than in other species, see Geldard, *The Human Senses*, 426–7.

There is no perception of dynamical relations or spatial relations in the world without our sense of balance. I would suggest that there is no perception of the world at all.

University of Tasmania