

British pioneers of research into human haptic perception

Jonathan Cole

The history of early research on haptics in the United Kingdom is, to a large extent, the history of several great men, reflecting in part the relative small numbers engaged in research. There was a golden age for British neurology and neurophysiology at the turn of the 19th and 20th Centuries, before and during the First World War. After this the focus moved to a smaller scale with the work of Adrian and Matthews; for instance, being largely on the mechanism of the nervous impulse and on biophysics rather than on the functioning of larger systems. Such were the successes of such an approach, with the accruing of Nobel Prizes for Adrian and Sherrington, Huxley and Hodgkin, and Katz, that whole system approaches only became in vogue once more within the UK in the latter decades of the last century.

Bell's handbook

Research on sensorimotor integration in the UK, and arguably elsewhere too, began with Bell. Sir Charles Bell (1774–1842) was a Scottish anatomist, artist, surgeon and physiologist. He is remembered for his eponymous facial palsy, for his long thoracic nerve and for the debate with Magendie over the sensory and motor natures of the dorsal and ventral nerve roots. But it is in his book, *The Hand; Its mechanism and vital endowments as evincing design*, that his enormous contribution to the subject of haptics was made [1]. The work considers many aspects of the hand, from comparative anatomy to even substitution of other organs for it. At one point he even discusses how animals were suited to the progressive changes in the earth and the elements, without taking any further steps towards Darwin.

But the heart of the book is on what today we might call neuroscience, both experimental and theoretical.¹

Throughout this rich and beautifully illustrated work (Bell was an accomplished artist), he also reveals the depth of his thought and his insights many of which appear to have been based on deduction.² He drew attention to the complexities of even a simple movement, which appear to have largely been taken for granted, “*we use our limbs without being conscious, or at least, without any conception of the thousand parts which must conform to a single act... by an effort of the cultivated mind we must rouse ourselves to observe things and actions of which sense has been lost by long familiarity.*”

Though, of course, it was Sherrington who coined the word proprioception, or self knowledge³, it was Bell who first described movement and position sense. “*We awake with a knowledge of the position of our limbs; This cannot be from a recollection of the action which placed them where they are; it must therefore, be a consciousness of their present condition.*” Bell, op cit.

Interestingly Ian Waterman, a man I have studied who has lost cutaneous touch and movement and position sense below the neck, describes exactly this problem when he wakes [2]. He has no idea where his legs are in bed under the sheets, and so moves them to find out.⁴ “*When a blind man, or a man with his eyes shut, stands upright... by what means is it that he maintains an erect position? How is it that a man inclines in due degree towards the winds? It is obvious that he has a sense by which he knows the inclination of his body and that he has a ready aptitude to adjust it.*

It can only be by the adjustment of muscles that the limbs are stiffened. There is no source of



FIGURE 1. SIR CHARLES BELL (1774–1842)

knowledge but a sense of the degree of exertion in his muscular frame...

In truth we stand by so fine an exercise of this power, and the muscles are, from habit, directed with so much precision and with an effort so slight, that we do not know how we stand. But if we attempt to walk on a narrow ledge, or stand in a situation where we are in danger of falling we become subject to apprehension; the actions of the muscles are magnified and demonstrative to the degree in which they are excited.

We are sensible of the position of our limbs... although we touch or see nothing. It must be a property internal to the frame... what can it be but a consciousness of the degree of action..." Bell, op cit.

He thus clearly describes a sense of movement and position, and also immediately brings our attention to two other aspects. Though describing them as a sense, he realises that they lie between consciousness and what is unat-

tended to and how even similar actions can be either automatic or filling our attention according to context, for instance when we walk or walk across a narrow ledge. In the phrase, "from habit", he implies that learning movements may be dealt with differently to habitual ones. Ian Waterman, without proprioception, describes how he does not know from one day to the next whether he will be able to make a movement; he is nearly devoid of habits, or automatic movements, all requiring mental concentration of a various degree.

"When we stand, we cannot raise or extend the arm without a new position of the body, and a poisoning of it, through the action of a hundred muscles.

Nothing appears simpler to use than raising an arm... yet in that single act, not only are innumerable muscles put into activity, but as many are thrown out of action, under the same act of volition." Bell, op cit.

Thus he describes the multiple synergies of action between muscles for even a simple single act. In the next passage he clearly showed he was thinking of active touch, of touch being through a combination of cutaneous sensation and manipulation of the tactile organ,

"Accompanying the exercise of touch, there is a desire of obtaining knowledge; in other words, a determination of the will towards the organ of the sense. Bichat says it is active when others are passive.

... in the use of the hand there is a double sense exercised; we must not only feel the contact of the object, but we must be sensible to the muscular effort which is made to reach it, or to grasp it with the fingers." Bell, op cit.

"When treating the senses, and showing how one organ profits by exercise of the other and how each is indebted to that of touch, I was led to observe that the sensibility of the skin is most dependent of all on the exercise of another quality. Without a sense of muscular action or consciousness of the degree of effort made, the proper sense of touch could hardly be an inlet to knowledge at all... the motion of the hand and fingers, and the sense or consciousness of their action must be combined with the sense of touch..."