Embodiment, ego-space and action Carnegie Mellon Symposia on Cognition Series, edited by R L Klatzky, B MacWhinney, M Behrmann; Psychology Press, Hove, Sussex 2008, 480 pages, **£45.00 (£40.50 online; US $67.50) ISBN 978 0 8058 6288 1**

Does an iguana lying still in the cool of the morning perceive a predator as being closer than it really is? If so, would this be an 'optical' effect of air temperature, an instance of the efficiency of embodied perception, or yet another mechanism? Although we could measure the iguana's brain activity we cannot really know what an iguana perceives; only observe that it begins its escape sooner when its body temperature is lower (Rocha and Bergalo 1990). But possessing a perceptual system that is modulated by the body's changing states and capabilities in the world could be a very useful and adaptive strategy. For if it takes longer to make an escape, why not represent the predator as being closer, or bigger? If you're low on calories, are overweight, or carrying a heavy pack, why not perceptually represent the hill as being steeper or longer? Bodily states and action possibilities may thus modify perception. Perception may also implicitly code the possibilities for action. These are some of the arguments presented in this new collection of chapters on the embodied nature of perception.

In recent years there has been—in some circles—a shift away from the idea of a disembodied mind that can be studied and understood in isolation from its bodily and environmental context. Embodiment (and even more so, the 'ego') are widely used terms and are understood in quite different ways by different authors. There is unfortunately no detailed attempt in this book to summarise some of the different (sometimes quite diametrically different) approaches to embodiment. There is also no discussion of some of the more radical embodiment-related claims (by, eg, Alva Noë and Kevin O'Reagan) that perception would be effectively impossible without implicit knowledge of sensorimotor contingencies. The book is nevertheless an interesting and informative survey of current thinking on how the body's possibilities for action and how multisensory body representations affect perception. The editors of this book propose that embodied perception and cognition reflects the fact that humans' perception and action is "influenced by their ongoing representations of themselves in that world" (page xi in Editor's preface). 'Influenced' is quite a non-committal word, but perhaps at this stage of research in the field it is wise to be equivocal on the exact form that this 'influence' takes.

The book's eleven chapters discuss topics as diverse as the perception of action in biological-motion displays (Shiffrar, chapter 4), embodied linguistc perspectives (MacWhinney, chapter 11) and the development of embodied cognition in infants (Adolph, chapter 9). One of the main unifying messages of this seemingly quite disparate collection is that as the possibilities for action inevitably change—owing to hunger, weight changes, fear, disease, age, expertise, temperature—so does what is perceived. These action possibilities change dramatically during the first few years of life when the infant's body is growing, changing and strengthening rapidly, and new skills—eg sitting, crawling and walking—are acquired. Adolph (chapter 9) has charted how these bodily changes are accompanied by changes in infants' perception of affordances—how their environment is perceived in relation to which actions are possible given the current developmental state and level of motor expertise. The chapter demonstrates that, rather surprisingly, despite rapid progress in learning to perceive what are necessarily ever-changing affordances, learning in one domain (crawling) does not help very much upon graduation to another (walking). "Each posture represents a different problem space defined by a unique set of parameters for maintaining balance. Each has a different key pivot around which the body rotates ... There are different vantage points for viewing the ground ahead, correlations between visual and vestibular information" (page 286). This brings home the impressive fact that an infant learning to crawl and walk does not just have to deal with constantly changing physical capabilities but also the corresponding changing perceptions of what actions are possible in and upon the world. We think it would have been a wonderful addition to compare infancy data with those from the other end of the age spectrum: How does embodiment affect perception in the elderly as some motor capacities are lost? Even more relevant could have been an analysis of perceptual changes in neurological patients with well-described motor deficits such as paraplegia, tetraplegia, extrapyramidal syndromes, or even patients suffering from locked-in syndrome.

Although infancy is a remarkable period for change in action possibilities because of rapid growth and skill acquisition, changes in perception related to physical expertise continue throughout adolescence and into adulthood. The impact of motor expertise on perception has

been shown in some extraordinary findings described in earlier chapters in this book. In Knoblich's chapter (chapter 2), we learn that pianists who were recorded performing an unfamiliar piece of music in the absence of auditory feedback (they couldn't hear themselves play) could afterwards distinguish between their own and another pianist's performance by hearing alone (Repp and Knoblich 2004). And subjects who were trained to perform an idiosyncratic arm movement while walking (and while blindfolded) were later able to recognise this movement when it was displayed to them visually (as a biological-motion stimulus), even though they had no previous visual experience of their action (Casile and Giese 2006). Somehow the motor representation is able to affect the judgment of the visual perception, but there is as yet no mechanism to explain how these and other similar intriguing feats are achieved. These are fascinating observations begging the question which brain areas might be involved in such functions. For example, is the auditory cortex in such pianists active although they do not hear, but only play music?

Other instances of bodily state influencing visual perception are discussed in chapters including those by Shiffrar on biological-motion perception (chapter 4) and by Proffit on the action-specificity of spatial perception (chapter 6). Proffit argues that "Perception relates spatial layout to one's abilities to perform intended actions and also to the inherent costs associated with their performance. In essence it is proposed that people see the world as 'reachers', 'graspers' and 'walkers' ... perception relates to and is influenced by three factors: the visually specified environment, the body, and purpose" (page 179). In support of this argument he discusses evidence that hills appear steeper and egocentric distances further when anticipated metabolic costs are greater (Proffit 2006).

Interestingly, Proffit and colleagues found that judgments of slope—which are always overestimated when making explicit judgments, even under normal circumstances—were much more accurate when subjects expressed their judgment via a visually guided action. By pressing their hand on a rotating palm board, subjects were able to closely match the slope of the board with the slope of the hill (Bhalla and Proffit 1999). This dissociation seems to be yet another example of the differential effects of processing stimuli in the two visual streams: the explicit judgments of slope may rely on ventral processing and the hand adjustments on dorsal representations. Proffit suggests that the conscious overestimation of slope is adaptive in that it facilitates conscious long-term planning, whereas overestimating slope for the moment-by-moment bodily interactions with the environment (that are mediated by the dorsal stream) would quickly cause problems if judgments made with that system were not veridical.

The difficulty in interpreting these and similar studies on embodied perception is ruling out the alternative hypothesis that it is not perception per se that is being altered, but some post-perceptual judgment process that is being affected, and in the first chapter Loomis and Philbeck make exactly this point. Further research—especially involving neuroimaging (there is only one chapter focusing on neuroimaging data)—could further illuminate this issue. And although it is probably too much to expect a book to provide its own critique, a collection of chapters on a theme such as this would benefit from a concluding chapter that tied the chapters together and lay out the challenges and unanswered questions that lay ahead. Even so, anyone interested in this arguably more holistic approach to understanding perception and cognition could learn a lot from these well-written and wide-ranging chapters. It will be interesting, in future years, to see how far embodied theories of cognition can take us, and where the limits of their explanatory powers may lie

Jane E Aspell, Olaf Blanke
Laboratory of Cognitive Neuroscience, Brain – Mind Institute, EPFL, CH 1015 Lausanne, Switzerland; e-mail: olaf.blanke@epfl.ch, jane.aspell@epfl.ch

References

Bhalla M, Proffit D R, 1999 "Visual – motor recalibration in geographical slant perception" *Journal of Experimental Psychology: Human Perception and Performance* **25** 1076 – 1096

Casile A, Giese M A, 2006 "Non-visual motor learning influences the recognition of biological motion" *Current Biology* **16** 69 – 74

Gibson E J, Walk R D, 1960 "The 'visual cliff' " *Scientific American* **202** 64 – 71

Proffit D R, 2006 "Embodied perception and the economy of action" *Perspectives on Psychological Science* **1** 110 – 122

Repp B H, Knoblich G, 2004 "Perceiving action identity: How pianists recognise their own performances" *Psychological Science* **15** 604 – 609

Rocha C F D, Bergalo H G, 1990 "Thermal biology and flight distance of *Tropidurus oreadicus (Saurra Iguanidae)* in an area of Amazonian Brazil" *Ethology, Ecology and Evolution* **2** 263 – 268