is that patients build up cognitive representations of the gestures. Their inaccuracy shows up independently from the motor actions used for expressing their content.

Brass and Heyes note that the old literature on neurological patients with apraxia is usually neglected but themselves neglect both old and new studies on apraxia. These studies cast severe doubts on the postulated superiority of sensory-motor ('generalist') over cognitive ('specialist') theories of imitation.

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Letters Response

Grasping the difference: what apraxia can tell us about theories of imitation

Reply to Goldenberg

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We are glad that our article has stimulated interest in the relationship between work on the clinical neuropsychology of apraxia and theories of imitation. However, we cannot agree with Goldenberg's recasting of the distinction between specialist and generalist theories [1] or, therefore, with his diagnosis of faults in the latter.

The generalist position proposes that imitation is based on task- and species-general processes of learning and motor control. It assumes, conventionally, that general mechanisms of motor control are implemented, not only in the primary sensorimotor cortex, but also in premotor and parietal association cortex. Thus, the generalist view is concerned with a higher-order, 'cognitive' level of motor control, and cannot therefore be contrasted, as Goldenberg suggests, with 'cognitive theories'.

As we outlined in our article [2], there is some evidence of weak somatotopic organization in the premotor and parietal cortex [3]. However, nobody would claim that there is evidence in these areas of the simple somatotopic organization found in the primary sensorimotor cortex [4]. Therefore, the generalist position does not rest on a strong somatotopy assumption, and is consistent with evidence that unilateral lesions can have bilateral effects on imitative performance.

Goldenberg's second, empirically-based objection is more interesting. How, he asks, can a generalist theory account for the fact that, among apraxic patients, impairments in imitation of meaningless gestures tend to correlate with impairments in the ability to reproduce the movements on a puppet or 'manikin' [5]. The answer lies in acknowledging that, when people are under instruction to imitate relatively complex and unfamiliar movements, as they are in most clinical tests, the task enlists a range of processes in addition to the visuo-motor connections, or 'matching vertical links', that are primarily responsible for solving the correspondence problem. For example, performance might depend on linguistic and non-linguistic processes involved in the sequencing and organization of motor primitives [6,7]. We suggest that it is processes of this kind, encompassed by generalist theory with reference to 'horizontal processes' and 'indirect vertical associations' [2,8], that can contribute to both imitation and manikin-manipulation impairments in apraxic patients.

The results of the manikin study [5] draw attention to the involvement of task-general mechanisms in imitation. Therefore, although Goldenberg disagrees with our emphasis on visuo-motor links, we seem to be united in believing that generalist rather than specialist mechanisms solve the correspondence problem.

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Book Review

Are emotions more than learned behaviors?

Emotions Explained by Edmund T. Rolls. Oxford University Press, 2005. £39.95/$75.00 (606 pp.) ISBN 0-19-857003-1

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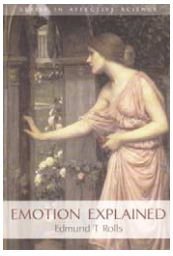

To 'explain' emotions, we must empirically envision how mammalian brains were designed, through evolution, to cope with many archetypal survival needs. In raw form, emotions probably reflect ancestral neuro-genetic memories that link up with capacities to learn about environmental contingencies. In this amplification and updating of his 1999 book, Edmund Rolls heeds some criticisms of his earlier efforts [1] but remains committed to his central thesis – that external rewards and punishments create emotional states.

For Rolls, the key to emotions lies among the sensorially-based *implicit* reinforcement processes that mold learned behaviors in 'lower' mammals and experiences of pleasure and distress among cerebrally most well-endowed species. He documents his rich behaviorist ideas with abundant evidence from superlative simian single-unit and human brain imaging studies of the correlates of sensory rewards.

Rolls claims that it is much easier to genetically encode emotionality within sensory-processing circuits than within emotional action systems of the brain. This debatable assertion leads him to ignore vast neuro-ethological comparative literature on the prototypic emotional behaviors that some deem essential for understanding this difficult topic [2,3]. But even as he exquisitely details how rewards and punishments impact learning and decision making, Rolls fails to grant most animals experiential affective states, reserving that for creatures capable of higher order symbolic processing.

Rolls showcases his critically important research on the neurophysiological correlates of sensory values (Chapters 1-4), how they relate to brain hunger (Chapter 5), thirst (Chapter 6), brain-stimulation reward (Chapter 7), drug reward (Chapter 8), and evolutionarily well-spiced sexuality systems (Chapter 9). For Rolls, such motivational-incentive processes constitute the core of emotionality, which, through higher cognitive read-out processes (Chapters 10-11), is transformed into feelings when an organism 'can think about its own thoughts' (p. 423). Several appendixes detail neuro-computational learning models of such processes.

This text, rich in interesting facts, is a fine tutorial on selected accomplishments of behavioral neuroscience, even for those who disagree, as do I, that core emotions, such as anger, fear, separation-distress and joy, are constructed from a few basic reward (approach) and punishment (avoidance) processes. Because Rolls prefers dimensional-associationist perspectives, there is little coverage of the brain sources of playfulness, maternal care-love, grief, or the experiences of anger, fear and desire, not to mention frustration and relief.

Those who envision that many specific emotional processes were evolutionarily built into mammalian brains, as raw (initially object-less, but not affect-less) psychobehavioral potentials (e.g. [4]), may remain perplexed with Rolls's attempt to make reinforcement learning as opposed to affectively rich action tendencies the central issue of the emotion puzzle. His position will turn out to be deeply flawed if sensory-affects are in the end quite distinct from the basic emotional-action affects, and if the associative efficacy of most rewards requires affective experience – Rolls assumes that they do not.

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