Perceptual learning

wine tasters, tea tasters, art connoisseurs have learnt to make very fine perceptual discriminations

the properties of visual neurons develop over time through experience. The "critical period" concept implies that the neural properties "freeze" after an initial period of plasticity

the phenomena of perceptual learning suggest that some plasticity must exist even in the adult visual system

some phenomena suggest that the plasticity happens as low as V1

Visual tasks that show perceptual learning

- stereopsis (O'Toole & Kersten, 1992), vernier acuity (alignment) (Poggio, Fahle, & Edelman, 1992), motion discrimination (Ball & Sekuler, 1987), texture discrimination (Karni & Sagi, 1991), pattern discrimination (Nazir & O'Regan, 1990).
- above cited studies all found that the learning was specific for trained location
- other studies find that learning is specific for stimulus spatial frequency, orientation, and direction of motion. E.g. Poggio et al (1992) found that training on horiz vernier acuity did not transfer to vertical version of task
- this degree of specificity suggests that the training affects the tuning properties of neurons at a low level (V1; or MT for moving stimuli). Such neurons are highly specific

Perceptual learning is different

unlike "normal" learning, perceptual learning can occur without feedback (Ball & Sekuler). Fahle & Edelman (1993) found that learning with feedback is only slightly faster than without

performance improves without reinforcement and does not seem to involve conscious effort

often normal learning decays rapidly; perceptual learning can persist for weeks with no further practice (Ball & Sekuler, 1987)

Fast and slow processes

- there appear to be two distinct processes
- strong improvements in performance have been found in just 1-2 short sessions. Then it plateaus
- fast process shows interocular transfer (Fiorentini & Berardi, 1982; Karni & Sagi, 1993)
- slow process: further improvement is possible if sessions spread across days
- why? Because sleep is necessary for consolidation.
- slow process does not show interocular transfer (Ball & Sekuler, 1987)

despite earlier ideas, it has been found that some neural plasticity exists in adults. Percep learning changes neurons

Zohary et al (1994): trained monkeys to discriminate motion direction. Directional tuning of MT cells changed

monkeys trained to discriminate slightly different sound frequencies develop larger cortical representations for the presented freqs than do control monkeys (Recanzone et al, 1993). Recanzone also observed that the neuronal frequency tuning was narrower

monkeys learning to make a tactile discrimination with one hand develop a larger cortical rep for that hand (Recanzone et al 1992)

Ball, K. & Sekuler, R. (1987). Direction-specific improvement in motion discrimination. Vision Research, 27, 953–965.

Fahle, M., & Edelman, S. (1993). Long-term learning in vernier acuity: Effects of stimulus orientation, range, and of feedback. Vision Research, 33, 397–412.

Fiorentini, A. & Berardi, N. (1982). Learning in grating waveform discrimination: Specificity for orientation and spatial frequency. Vision Research, 21, 1149–1158.

Karni, A. & Sagi, D. (1991). Where practice makes perfect in texture discrimination: Evidence for primary visual cortex plasticity. Proceedings of the National Academy of Sciences USA, 88, 4966–4970.

Karni, A. & Sagi, D. (1993). The time course of learning a visual skill. Nature, 365, 250–252.

Nazir, T.A., & O'Regan, J.K. (1990). Some results on translation inavriance n the human visual system. Spatial Vision, 5, 81–100.

O'Toole, A. J., & Kersten, D. J. (1992). Learning to see random-dot tereograms. Perception, 21, 227–243.

Poggio, T., Fahle, M., & Edelman, S. (1992). Fast perceptual learning in sual hyperacuity. Science, 256, 1018–1021.

Recanzone, G. H., Mersenich, M. M. & Jenkins, W.M. (1992). Frequency iscrimination training engaging a restricted skin surface results in an mergence of a cutaneous response zone in cortical area 3a. Journal of europhysiology, 67, 1057–1070.

Recanzone, G. H., Schreiner, C. E., & Mersenich, M. M. (1993). Plasticity in he frequency representation of primary auditory cortex following discrimination aining in adult owl monkeys. Journal of Neuroscience, 13, 87–103.

Zohary, E., Celebrini, S., Britten, K. H., & Newsome, W. T. (1994). Plasticity hat underlies improvement in perceptual performance. Science, 263, 1289–292.