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Borsellino College 2007. Spike Trains to Actions: Brain Basis of Behavior

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The brain basis of musical performance

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Fifth Antonio Borsellino College on Neurophysics:
"SPIKE TRAINS TO ACTIONS: BRAIN BASIS OF BEHAVIOR"

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OUTLINE OF TALK

THE BRAIN BASIS OF MUSICAL PERFORMANCE

This lecture will discuss the neuroscience of music (and dance), high-level, socially-organized actions. Music experiences and skills are universal in all human societies, and components may be present in different forms in whale, bird, gibbon, and mouse, among other species. Dance, patterned movement entrained to others and to music, appears uniquely, universally human. Human music, like human language, is complex, governed by rules, and acquired in developmental stages, with all individuals acquiring a basic musical appreciation, and others going on to develop highly expert skills. Such evidence suggests that music is a consequence of biological evolution and is associated with specific brain architecture. I will review findings indicating that indeed there are discrete brain systems and computations for particular music experiences and skills, and that these systems are distributed throughout the whole brain.

Topic Outline

Evolution, Cross Species Comparisons
Brain Systems for Dance
Human Brain Systems for Singing Melody, Harmony
Comparison of Brain Systems for Music and Language: Generation/Improvisation
Effect of Expertise and Context on Brain Systems for Music and Language
Brain Systems for Rhythm and Performance
Research Topics on the Horizon

The Cerebellum

The cerebellum contains about 70% of human neurons and its microcircuitry is remarkably conserved across the vertebrate line. Although it has been long thought to be strictly a motor control structure, new anatomical, neurological, and neuroimaging findings implicate it in a wide variety of non-motor information processing. New evidence casts doubt on classic "beam" hypotheses of cerebellar cortex physiology and circuitry. New functional findings suggest cerebellar support for such processes: (a) perception of visual motion, speed, and direction; (b) perception of duration; (c) olfaction; (d) kinesthetic/proprioceptive processing; (e) tactile/cutaneous processing; (f) perception of phonemes; (g) regulation of affect; (h) verbal working memory; (i) language use; (j) spatial cognition; (k) auditory localization; (l) executive functions; (m) food hunger; (n) thirst; (o) air hunger; and (p) the fine discrimination of auditory pitch. There are even data suggest it does not process motor information per se. Moreover, it has been recently implicated to some degree in autism, dyslexia, ADHD, problems in short term phonological memory, specific language impairment, alcoholism, fetal alcohol spectrum disorders, Williams Syndrome, and schizophrenia. The implications of these findings for theories of cerebellar function will be discussed.