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INTERSENSORY COORDINATION

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Perception of body orientation and configuration is dependent on multiple sources of afferent and efferent information about the spatial configuration of the body and its relationship to the support and force characteristics of the surroundings. Such information allows us under normal circumstances to preserve an accurate and stable distinction between those changes in receptor activity contingent on self-motion and those contingent on motion of or within the environment. Maintenance of this distinction is essential for the ongoing control of normal body movement and posture.

Because of this active interrelating of sensory and motor cues whenever there is an error in the registration of ongoing body orientation, auditory and visual mislocalizations of related magnitude and time course can occur. As a consequence, depending on the perceived spatial representation of the body, identical patterns of arrival time and intensity cues at the ears (and identical retinal and oculomotor signals) can give rise to the perception of sounds (and visual objects) in widely disparate spatial positions in relation to the head and to the external environment. The interaction between sensory localization and the representation of body orientation is actually bidirectional. For example, a rotating sound field can elicit illusory self-rotation and compensatory eye movements in a stationary listener.

The conscious appreciation of limb position is influenced by muscle afferent signals. When the body or tendon of a muscle is mechanically vibrated, for example at 120 Hz, the muscle reflexly contracts. This contraction is known as a tonic vibration reflex (TVR). If the motion of a limb moving under the action of a TVR is resisted, illusory motion of the (unseen) stationary limb will be experienced. For example, if the biceps brachii muscle is vibrated, the restrained forearm will be felt to move into extension. A target light attached to the stationary index finger of the hand, in an otherwise dark room, will be seen to move in keeping with the apparent motion of the arm even though the eyes maintain steady fixation. If the subject is allowed to see his index finger in relation to the surroundings, but not the rest of his forearm, he will see his finger in one spatial location and feel the rest of his arm to be in another spatially distinct location.

During body movement in a high force field, the relationship between muscle activity and muscle spindle feedback is altered, much as in the case of the vibration illusions just described. If an individual does deep knee bends during exposure to twice earth gravity, then he will misperceive the extent of his own voluntary motion and simultaneously experience visual motion of his surroundings by the amount of that misperception. This demonstrates that there is a dynamic relationship between intended movements and the actual movements executed, and the perception of those movements.

During normal terrestrial locomotion, deformation of the optic projection of the visual world, the intensity and timing of efferent signals and of muscle afferent signals, and the distribution of contact forces of support on the body co-vary and are mutually corroborative. If the relationship between voluntary stepping movements, body displacement, and visual flow are artificially altered, it is possible to distort the perception of voluntary actions so that an individual voluntarily stepping forward can perceive himself to be voluntarily walking backwards, or to be stepping more slowly or more rapidly than he actually is. Common to all the remappings elicited are combinations of perceived self-motion, perceived limb activity, seen motion of the visual world, and felt motion of the ground that are dimensionally consistent (even if not physically probable, such as changes in apparent leg length) with minimal departures from terrestrial constraints.