Future

Both empirical and modeling studies have also demonstrated the usefulness of the TCT in the explanation of learning, memory, kinesthesia, and neurological movement disorders (Feldman et al. 2007) and no doubt these aspects of the TCT are worthy of further development. Even these future advances will not spell the end of the development of the TCT. Where can one go from here? Note that the scheme in Fig. 8 is not just an explanation of the physiological origin of threshold control. It implies that motoneurons and many other neurons are cognitive devices that recognize when the values of respective physical variables delivered to their inputs from sensory receptors match the centrally specified, referent values of the same variables. Moreover, these devices signal to muscles or other neurons the degree of the discrepancy between these variables and thus tend to diminish the discrepancy, as the principle of minimal action suggests. Threshold control thus provides a principal answer to the question of how the nervous system can identify that some internal (referent) and external (physical) events match each other: motoneurons and neurons are skillful in this function. The development of these, cognitive aspects of the TCT might be beneficial for the understanding of the functioning of different brain structures. Indeed, the cognitive aspects can be developed within the TCT based on the notion that frames of reference for action and perception are united (see Introduction).

The history of the EP hypothesis and its development might be a good illustration of the notion that "problems cannot be solved by thinking within the framework in which the problems were created" (Albert Einstein; a quote from Pound 2004). In essence, the posture-movement problem and redundancy problems in multi-muscle and multi-joint control appeared as such within the mechanical framework. As soon as thinking went beyond the mechanical framework by taking into account threshold position control and the principle of minimal action, these problems are solved in a natural way. Thereby, it came out that neural control levels are not pre-occupied in solving these problems: these levels guide motor actions by specifying where, rather than which and how, neuromuscular elements should work and rely on the capacity of these elements and the environment to yield each time a unique action.

Recommended reading for students: Von Holst and Mittelstaedt (1950/1973); Matthews (1959); Feldman and Orlovsky (1972); Nichols and Steeves (1986); Feldman and Latash (1982); Hogan and Flash (1987); Latash (1993); Feldman and Levin 1995; Won and Hogan N (1995); Gribble et al. 1998; Levin (2000); Ostry and Feldman (2003); St-Onge and Feldman (2004); Feldman (2008); Foisy and Feldman (2006); Feldman et al. 2007; Pilon et al. (2007)

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