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## Summary

Spontaneous movements of human neonates were studied from a dynamic perspective. Application of recurrence plot analysis and symbolic dynamics of kinematic data of the movement behavior of the four limbs, arms and legs, revealed the following principles of organization:

1. The coordination of four single behavioral channels (arms and legs) into one channel of behavior (a sequence of configurations) that involved the dynamics of the four subsystems.
2. The segmentation of the movement flow into nested movement units (movement phrases consisting of movement elements).
3. The emergence of transient attractors (reference configurations).
4. The alternation between qualitatively distinct dynamical regimes: (a) between active and passive, (b) between linear and nonlinear and (c) between the presence and absence of reference configurations (attractors).

It is assumed that these principles of organization result from partial synchronization of the movements of the four limbs that evolves from self-organization - a dynamical interaction of the four subsystems (arms and legs) - due to natural mechanisms of constraining the degrees of freedom. Furthermore it is concluded that these principles of coordination do not result from superior neuronal activities that govern the movement behavior, but emerge from the mutual interaction of the biodynamical properties of the body. The possibility that afferent feedback-loops that act on spontaneous network generated activity create interferences, which in turn affect via early spinocortical tracts the patterning of developing cognitive functions, is not ruled out.

The biological significance of the results is addressed by the description of the principles of organization of neonatal limb kinematics in a dynamic terminology revealing that the self organization of the physical apparatus is continuous with higher cognitive processes: (1) multiple stable regions in phase space allow for optimal adaptability, (2) the freeing and freezing of degrees of freedom facilitate learning and (3) the recurrence of the same principles in different contextual frameworks allows for abstraction. Therefore the results of this study are proposed to serve as a contribution to the idea of an embodied cognitive system with the self organizing interaction of the physical apparatus and the nervous system as a first stage of development in forming higher organizational levels of abstraction.