PRINCIPLES OF SELF-ORGANIZATION

IN SPONTANEOUS MOVEMENTS OF HUMAN NEONATES

Dissertation

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Preface

This thesis documents my research as a Ph.D. student at the Free University Berlin. The research was designed to elucidate the origin and role of the spontaneous motor activity of human neonates in the early motor and cognitive development. As a first step into such direction the following articles were published in/ submitted to international journals:

Aßmann B, Hahn S & Niemitz C (2007) Emergence of transient attractors in four-limb coordination of human neonates. *Conference Proceedings of the International Congress of Neuroethology 2007, Vancouver.*

Aßmann B, Hahn S & Niemitz C (2007) On the generation of goal representations. *Infant Behavior and Development*, submitted. – (Dissertation: Chapter 4)

Aßmann B, Thiel M, Romano CM & Niemitz C (2007) Hierarchical Organization in motor behavior of neonates. *Infant Behavior and Development*, doi:10.1016/infbeh.2007.04.004. – (Dissertation: Chapter 3)

Aßmann B (2006) Spontaneous newborn movements from a comparative perspective. In Niemitz C (eds), Brennpunkte und Perspektiven der aktuellen Anthropologie*, Beihefte zu den Mitteilungen der Berliner Gesellschaft für Anthropologie, Ethnologie und Urgeschichte,* Band 1, in press.

Aßmann B, Thiel M, Romano CM & Niemitz C (2006) Recurrence plot analyses suggests a novel reference system involved in spontaneous newborn movements. *Behavior Research Methods*, 38 (3), 400-406. – (Dissertation: Chapter 2)

Aßmann B, Romano CM, Thiel M & Niemitz C (2006) A reference system in newborn motor behavior suggests goal directedness. *Conference proceedings of the first Joint ESMAC & GCMAS Meeting 2006, Amsterdam*.

Aßmann B, Thiel M, Romano CM & Niemitz C (2005) Recurrence plot analyses suggests a novel reference system involved in spontaneous newborn movements. *Conference Proceedings of the 5th International Conference on Methods and Techniques in Behavioral Research, Measuring Behavior* 2005.

The core of the present work consists of 3 studies (chapter 2 – 4) that are self-contained in respect of content orientation and related to each other in terms of applied methods and the analysis of the same data set. These studies are framed by a general introduction (chapter 1) that introduces the theoretical background and applied methods, and a general discussion (Chapter 5) that summarizes aspects of the three studies and furthers broader perspectives.

Chapter 2 is a methodological study that presents (i) how the dynamic systems perspective and methods derived from this approach - recurrence plot analyses and symbolic dynamics – can reveal organizational principles in the overall movement system of neonates

and (ii) how these results become insightful by relation to other behavioral studies. Indices of a reference system consisting of four dimensional body configurations of the limbs are discussed in reference to parallels in home base behavior of rats. In chapter 3, single limb behavior is investigated in more detail in respect to the interaction that results in the emergence of configurations. The analysis of recurrence plots is extended to recurrence quantification analyses and pattern formation on different time scales is discussed from a behavioral view of a structural hierarchy. In the study presented in chapter 4 the distance trajectories of the distal effectors hands and feet are investigated by using symbolic dynamics. Analysis of the distributions of reference configurations suggested mechanisms, by which goal representations might be developed.

During the process of publication, it was suggested to modify some terms. These modifications concern the following terms: ‘home base configuration’ (chapter 2) refers to ‘reference configuration’ (chapter 3,4); ‘cumulative time of staying’ (chapter 2,3) refers to ‘occurrence’ (chapter 4); ‘frequency of recurrence’ (chapter 2,3) refers to ‘recurrence’ (chapter 4).

In chapter 5, the general discussion, the results from these studies are summarized and regarded in respect to contributing or underlying mechanisms - biomechanical properties of the body, reflex pathways and spontaneous neural activity in the spinal cord – whose interaction resulted in the formation of coordinative patterns. Pattern formation in spontaneous newborn movements is not assumed to be a cognitive strategy but to emanate from the interaction of the network driven spontaneous neural activity of the spinal cord and the biomechanical properties of the body. I suggest that in the course of efferent and afferent activity, the latter are incorporated into the active patterning of the nervous system and higher brain functions.

Declaration: I developed all concepts and the methodology of my thesis, collected and analysed all data presented here and created the written version of this thesis.

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