Title

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Journal

Proceedings of the Annual Meeting of the Cognitive Science Society, 42(0)

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Publication Date

2020

Peer reviewed

Structured ecologies for social and linguistic development

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Abstract

This is a joint work of two labs that offers a perspective on development and learning, which complements the conference's focus on "changes in representation and processing abilities in development". Strong background in ecological psychology allowed us to recognize the richness and multilayered structuring of infants' environment, which actively engages them and to which infants tune their action-perception. We conceptualize this environment as reliable "social physics", constituted of predictable, enacted social events, in which infants learn to participate. Using both traditional (qualitative and quantitative) and dynamical systems methods, we show the structuring of such events on multiple timescales and levels and how participating in them sculpts the child's agency in the social world. We show how this background allows a fresh look on language acquisition and how it informs computational modelling of language emergence and models of human-robot interaction.

Keywords: ecological psychology, social development; language development; mother-infant interaction; routines

Growing up in social physics

This publication-based paper presents joint work from two labs, which integrated their expertise in qualitative and quantitative mother-infant interaction microanalysis and in ecological psychology and dynamical systems methods in order to account for the changing "Umwelt" of the child. In a complementary effort to the theories that "reflect the developmental trajectories and the changes in representation and processing abilities" we focus on the environment in relation to which such changes occur.

Congruently with the main tenets of the ecological psychology: "(…) animate beings unlike inanimate things are: a) ceaselessly active and b) continually in the process of engaging their surroundings in a selective manner. (…) animate beings exist in relation to a flow of events, and their functioning is best understood as that of dynamic, organismic process in context." (Heft, 2001, p. xxiii). Accounting for learning in humans, animals and machines, therefore involves accounting for the "Environment considered in its full complexity, including at multiple levels of its organization." (ibid. p. xxiv)

Yet in the case of developmental contexts of humans and many other species, the context in relation to which cognition is structured is itself active and selectively engaging. Unlike physical events, social events are enacted by others but like the physical world also provide causal, reliable and thus predictable structure. It is this "social physics" that we set out to investigate, in its multilevel and multi-timescale complexity, underscoring how it hinges on infant's active participation and how it shapes infant's agency for social and linguistic interaction. In this task we integrated methods of qualitative and quantitative microanalyses based on hand-coding mother-infant interactions developed by Katharina Rohlfing at the U. of Paderborn lab together with Iris Nomikou (now Plymouth U.) with dynamical systems recurrence analyses performed at the U. of Warsaw Human Interactivity and Language Lab.

Levels of Participation

The theoretical foundations, scaling up the intentional development of a child as agent in the physical world from Gibson's original work to navigating "social physics" were laid out in our 2013 paper. Using the work of Merleau-Ponty (1945/1963) and Heft (1989) we traced the purposefulness of interaction and individual actions to being immersed in culturally re-enacted events or "projects". Such events, unfolding on various timescales, give the infants' movements directionality and social sense. The child learns patterns of agency in contexts: that the movements of others are affordances for own actions and that owns actions can be affordances for the others. We supported the framework by qualitative analyses of particular interactive situations in which we show how the infant, swept by enacted routine sequences and timings, learns – often "movement first" – how to properly navigate this enacted world.

We also show (Nomikou & Rączaszek-Leonardi, 2015) how this "propriety" of movements in interaction is dictated not only by the efficiency of coordination, a momentary functionality of joint action but by multiple values preserved and instilled by particular timings and sequences of actions, such as mutual respect and agency of the participants.

In subsequent 6 papers we detail the main events in social physics and ways in which they engage the child.

Coupling Gaze and Vocalizations Using hand-coded mother-infant interactions from the Bielefeld corpus combined with recurrence analysis, we showed evolution of gaze-coupling, from unspecific, prolonged gaze-locking at 3 months of infant's age, to a more precisely timed mutual gaze relations (Nomikou et al., 2016). Similarly, in vocal modality, we show progressive turn-taking tendencies in vocalizations (Leonardi et al., 2016). Both gaze and vocal patterning reflect the informational coupling of the

interaction participants, already defining their mutual constraining relation and providing background for coordination in progressively more complex projects. Later we broaden the analyses to multimodal contingencies (Rohlfing et al., 2019)

Towards agency in complex events The subsequent two papers analyze the notion of agency in mother-infant dyads. We show how re-enacted events structure the individual and joint agency on several time-scales (Rączaszek-Leonardi, 2017). We also use both qualitative and statistical analyses to demonstrate how the complex structures of jointly enacted "projects" require specific agency of an infant at specific moments and how the agency of the mother impinges of infant's agency in non-adjacent points in a sequence of events (Nomikou et al., 2017).

Supported by our collaborator, Nicole Rossmanith, who joined the team with her work and insights on jointly enacted action arcs, we underscore the importance of such energy contours, showing how this aids in explaining the directedness and coherence of enacted events, providing a narrative, affect-laden structure both to simple events and to more complex "projects" (Rossmanith, et al., 2014; Rączaszek-Leonardi et al., 2019).

Language in social physics

The above background gave us insights on the structuring of the ecologies for social development. This, in turn, offered a good view-point for assessing the place and role of language as a specific joint activity which poses additional constraints on coordination, while basing on the above principles of co-action in social physics (Rączaszek-Leonardi, 2016). The obvious grounding of language in co-action, allowed us a fresh look at language learning and language emergence. Thus, understood as joint achievement, language learning occurs in specific pragmatic frames, a multimodal, joint (dialogical) "learning units" co-constructed with a partner (Rohlfing et al., 2016). On the other hand, a tight coupling to co-action poses hard problems of how language can gain its systemic and abstract properties (the "symbol ungrounding problem", Rączaszek-Leonardi et al., 2018). The collaboration continues on the theoretical level but also dovetails into work on communicating with artificial agents and computational modeling of language emergence.

Acknowledgments

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