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Same or different: Common pathways of behavioral biomarkers in infants and children with neurodevelopmental disorders?

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Abstract: The extent to which early motor patterns represent antecedents to later communicative functions, and the emergence of gesture and/or sign as potential communicative acts in neurodevelopmental disorders (NDDs), are research questions that have received recent attention. It is important to keep in mind that different NDDs have different neurological underpinnings, with correspondingly different implications for their conceptualization, detection, and treatment.

Ontogenetic origins of certain motor patterns and their communicative functionality do not necessarily go hand in hand. The ability to extend the index finger, for example, is present already prenatally (e.g., Marschik et al. 2013, Fig. 1), but becomes functional only several months later (e.g., Behne et al. 2012; Matthews et al. 2012). Physiological studies on the antecedents of later communicative functions, along with research on pathophysiological profiles, suggest the need for caution in assigning and interpreting the communicative intent of early emerging gestures. From a perspective valuing age-specificity, be it developmentalist or neuroconstructivist, for example, it is clear that an "adult-

cognitive-linguistic-brain perspective” fails to explain the pathway to functionality.

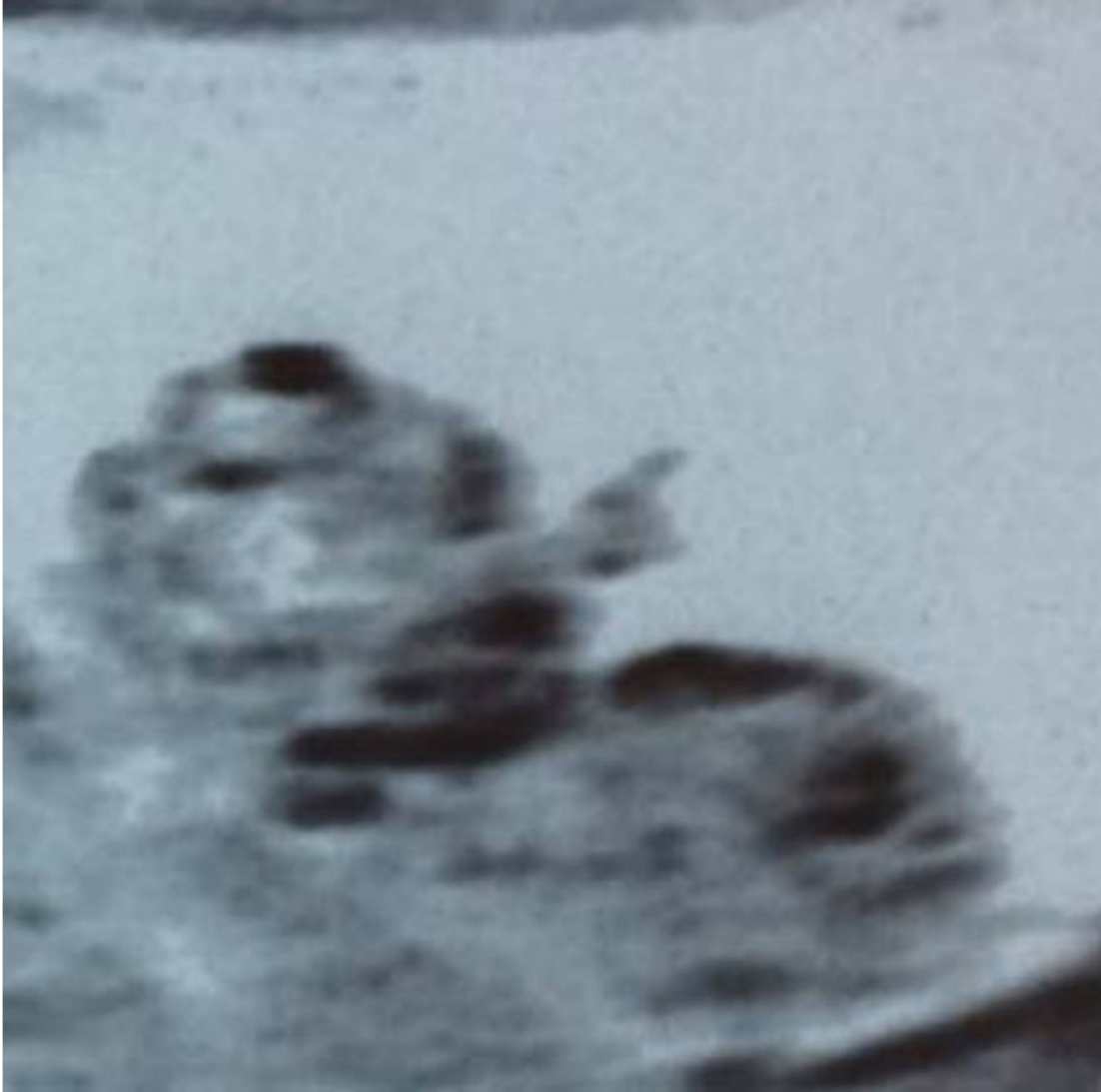


Figure 1 (Marschik et al.). □ Ultrasound video print of a 13-week-old fetus extending the index finger.

As with verbal abilities, gestures and/or signs have to be seen and studied as emerging age-specific phenomena. At which point in development can we claim that an extension of the index finger, for example, represents indexical pointing, is requisite, and/or is intentional or informative? Considering development beyond the “pure” index finger, how can we assume, from an adult theorist perspective, that and when a beginning communicator is creating or acquiring “communicative units” or “multi-modal communication packages”? How does

he/she use these units or “packages,” be they signs or gestures? And does this differentiation of signs and gestures help to understand communicative development in children with neurodevelopmental disorders (NDDs) who often do not develop speech and instead rely mainly on nonverbal and prelinguistic means to communicate?

In searching for the keys that might enable children with NDDs to better communicate, it is admittedly a struggle to understand the wealth of theoretical frameworks on cognition and linguistics that have been brought to bear on the many questions that arise in this search. For example, should toddlers be viewed as “mini-linguists” or “constructivists”? Without dwelling on this fundamental query, we have to re-stress that the attempts to conceptualize development applying theoretical approaches from adult linguistic systems need to be reframed. To this end, an autopoietic structure-function model that integrates bootstrapping and idiosyncrasy components might be useful for the earlier and more accurate detection of NDDs, especially those NDDs where the diagnosis is usually not made until later toddlerhood (e.g., autism spectrum disorder [ASD], Rett syndrome, and fragile X syndrome). Such a model intends to decipher early gesture development and gesture-word dependencies as sensitive markers to evaluate the integrity of the developing nervous system.

Studying (mal)development of communicative forms as “potential communicative acts” in individuals with NDDs faces great challenges, but could have enormous potential for understanding the development of gestures and signs, as well as enabling earlier and differential diagnosis of neurodevelopmental disorders. To date, few studies have conducted systematic comparisons across different NDDs. Existing studies in this area have found that the presence or absence of communicative gestures is a significant predictor of language in Down syndrome, ASD, and specific language impairment, but less predictive for Williams syndrome and fragile X syndrome (Luyster et al. 2011), suggesting syndrome-specific developmental patterns. Our own studies (Bartl-Pokorny et al. 2013; Marschik et al. 2012a; 2012b; 2014a; 2014b) are consistent with this suggestion, but also indicate the need to be cautious in attributing communicative intent or functionality to the gestures and signs of such children. Not only do we have to define the onset of functionality of certain behaviors as being communicative, but we also have to consider the cause for the paucity of communicative gestures that is associated with many NDDs. It is possible that this paucity could be related to impairments in symbolic representation or deficiencies in motor planning rather than cognitive functioning.

Goldin-Meadow & Brentari (G-M&B) stated in the target article that gesture is an integral part of language—it forms a unified system with speech and, as such, plays a role in processing and learning language and other cognitive skills. Is it then appropriate to talk about gestural development – “the manual movements that speakers produce when they talk” (para. 3)—in infants and toddlers with NDDs who fail to achieve even the earliest speech-language milestones? Or is it more useful to consider relevant behaviors a visible action as utterance

(Kendon [2004](#)), a superordinate term for gestures and signs?

In the discussion about modality and iconicity, G-M&B stated, by referring to the work of Ferdinand de Saussure, that “having iconicity in a system does not preclude arbitrariness, which is often taken as a criterion for language” (sect. 1., para. 2). From a developmental/nonadult point of view, how far is iconicity an enhancing factor to acquire basic socio-pragmatic functions for children with NDDs? And how far is the typical Gestalt perception, and thus the ability to delineate the iconic character of a sign or gesture, perceived in a similar way in children with NDDs (Bölte et al. [2007](#))? An icon may be equally hard to acquire as a conventional form, be it a word or a gesture/sign, for somebody who is atypically structuring their communicative domain. In other words, onomatopoeic sounds (e.g., meow) or arbitrary words (e.g., cat) may even have similar levels of arbitrariness in children with NDDs.

Given the importance of theoretical frameworks of socio-communicative abilities, for us – as behaviorally oriented neuroscientists – it is important to keep in mind that different NDDs may have different neurological underpinnings. They need to be interpreted from a developmental perspective, each disorder in its own right, with correspondingly different implications for their conceptualization, detection, and treatment.