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The interaction of music and language in the ontogenesis of human communication: A multimodal parent-infant co-regulation system

by MARTINE VAN PUYVELDE, FABIA FRANCO

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Abstract

This article presents a hypothetical model on the missing link between music, language and the ontogenesis of human communication. Based on a selected review of specific studies into musical aspects of early vocal communication and their potential links with forms of social-affective, physiological and cognitive co-regulation, we want to sketch a potential function of music and language for human development.

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Background

In 1871, Darwin speculated that '...the rhythms and cadences of oratory are derived from previously developed musical power.... Musical sounds afforded one of the bases for the development of language' (1871, p. 336). Yet, only in the last decade has the study of the relationship between language and music received considerable attention in science. Language and music are two major communication systems in humans - both have everyday usages studied by psychologists and neuroscientists on the one hand, and musicologists and linguists on the other; both have literacy forms associated with them, begging educational considerations; both have evolved artistic forms through human history and across different cultures, and both have brought art to the core of socially organized endeavors to promote cross-domain benefits, *e.g.* El Sistema (Majno, 2012). Although research has been fast-growing, how language and music interact in the ontogenesis of human communication from birth has not been thoroughly explored. Moreover, it has not been taken into consideration whether this early interaction may have a social-developmental function. There is a need to uncover the missing link and to reflect on the fundamental question of how the relationship between language and music evolves during the early stages of human development on the one hand and how this development may support in the building of social relationships on the other hand.

Aims

The aim of this article is twofold: 1) to propose a hypothetical model on the missing link between music, language and the ontogenesis of human communication, and 2) to sketch a potential function of social-affective,

physiological and cognitive co-regulatory mechanisms in the proposed developmental model of music/language. In the next section, we will provide a selective review of specific studies into musical and multimodal aspects of early vocal communication.

Main Contribution

The development of human communication and language from a musical perspective

The development of human communication and language is a complex learning process that evolves from the beginning of life through daily social interactions. Transitioning over different reflexive and non-reflexive stages, infants gradually improve their vocal learning through experiences of face-to-face interaction (Locke, 1993; Oller, 2000). Research has shown that the development of infant vocal production is related to contingent stimulation from adult caregivers, who selectively reinforce specific vocal features (*e.g.* Gratier & Devouche, 2011). For instance, during the first year of life, infants are fine-tuning their sensitivity to native language-specific properties (*e.g.* Mattock, Molnar, Polka, & Burnham, 2008; Snow, 2006; Werker & Tees, 2002) and develop systematic intonation patterns associated with context-dependent information from their social environment (D'Odorico & Franco, 1991).

Such interest in intonation and melodic patterns in parent-infant interaction has opened the door to a new interdisciplinary research domain, approaching the developing vocal and social interaction from a musical perspective. This approach highlights the musical aspects of these early vocal dialogues and proposes a fundamental role for a communicative musicality enabling infants to connect with their social environment in unique ways (Malloch & Trevarthen, 2008). For instance, researchers have described the character of mother-infant vocal rhythmic timing by analogy to jazz improvisation (Gratier, 2008; Schögler, 1998), and have begun to elucidate the unique phonetic and melodic features of mother-infant pitch exchanges (Fernald, Marchman, & Weisleder, 2013; Papoušek & Papoušek, 1989; Van Puyvelde *et al.*, 2010; Vosoughi, Roy, Frank, & Roy, 2010; Vasoughi & Roy, 2012) and maternal acoustic adaptations in timbre (Malloch & Trevarthen, 2008). Additionally, in-depth acoustical analyses of early vocal interactions have revealed that musical qualities within mother-infant pitch

patterns contribute to moments of shared vocal engagement or 'tonal synchrony' (Van Puyvelde *et al.*, 2010). During tonal synchrony, mothers' and infants' successive vocalizations are related to each other according to acoustical laws of tonality involving particular integer pitch-ratios of the harmonic series. Moreover, when relying on tonal synchrony, mothers and infants appear to be involved in a game of 'social negotiation', attempting to repair or match their mutual social engagement (Van Puyvelde *et al.*, 2013). Additionally, tonal synchrony has been demonstrated in relation to mother-infant physiological co-regulation (Van Puyvelde *et al.*, 2014). When comparing heart rate variation (respiratory sinus arrhythmia - RSA) of mothers and their three-month old infants to music characterized by tonally synchronized vs. non-tonally synchronized aspects, physiological co-regulation was found only with the former. However, the precise intertwinement between the roots of music and language within the ontogenesis of human communication remains a complex puzzle.

Brown's 'Musilanguage Model' as a base for understanding the development of musicality in vocal learning

From an evolutionary perspective, Brown (2001) has suggested that music and language evolved as two homologues from a common ancestor, specializing in different directions but sharing a significant amount of structural features. These shared features would be the evolutionary roots for a form of communication that was neither musical nor linguistic but 'musilinguistic'. Distinctive musical vs. linguistic features would have emerged later in evolution. We believe that the musilanguage model may be meaningfully extended to encompass the findings on musicality within early caregiver-infant vocal communication. Namely, we speculate that the musical qualities of these early vocal dialogues (accompanied by their rich multimodal dimensions) occupy a similar 'border zone' in the ontogeny of language development, a zone where communication may be neither musical nor linguistic but rather exists as a foundational source of meaning and relatedness, from which both musical and linguistic capacities will develop. If so, it is crucial to address the question concerning the developmental stage at which a distinction occurs between the musical and linguistic pathways.

Research on the use of suprasegmental features of vocalisations, such as pitch contours (D'Odorico & Franco, 1991), temporal characteristics (D'Odorico Franco, & Vidotto, 1985; D'Odorico & Franco 1991) and manner of phonation (Franco, 1984) identified an early intonation-related sound-

meaning system, which appeared to break down in the second part of the first year of life (D'Odorico & Franco, 1991; Snow, 2006). Between the age of six and twenty-three months, at the time when perceptual narrowing happens (Werker & Tees, 2002), infants' intonation regresses and reorganizes (Snow, 2006). This is the period in which a restriction of phonetic discrimination to mother-tongue phonemes occurs and the convergence towards native phoneme targets begins to be established at a productive level. We speculate as to whether this critical period may mirror the phylogenetic transition point suggested by Brown (2001), by paving the way to the gradual distinction between language and music at the ontogenetic level. Using implicit measures based on eye-tracking, Franco, Sobolewska, Stewart and Waller (2015) suggested that similarities and differences between the multimodal processing of song and speech may emerge during the first year of life.

The music/language specialization point of transition may also be part of a more complex general mind-body integration process that is critical for healthy human development, as described in consolidated neurovisceral integration models. For instance, Thayer and Lane (2000) suggested that mind-body integration processes between the brain and the autonomic nervous system would allow us to respond in a flexible manner to environmental challenges. Indeed, in physiological studies of mother-infant responses to language-related music, a clear difference in music processing between adults and infants was observed (Van Puyvelde *et al.*, 2014). Mothers showed an integrated top-down regulated mind-body response to the music (as in Thayer & Lane, 2000) whereas infants appeared to respond via bottom-up processes.

Finally, recent research investigating the cognitive benefits of listening to music in different age-groups (from 3-year-olds to adults) revealed that cognitive performance was affected not by musical variables *per se*, but rather by the interaction between musical affect and the listener's affective state (Franco *et al.*, 2014), with cognitive benefits associated only with mood-congruent music, even when affect was negative. This perceptual mechanism is likely to evolve in infancy as an inter-individual adaptive mechanism between baby and caregiver. Thus, the research agenda should focus on two questions: 1) how and when top-down processes start interacting with physiological responses in music perception, and 2) which are the boundaries of the developmental window in which common music-language roots split in distinctive but interacting pathways.

Conclusions

A hypothetical model of the ontogenesis of human communication: a parent-infant co-regulation system

Based on the aforementioned research, we suggest that a music-language relationship may be functional in the development of human communication, being an important source for later integrated mind-body functioning. That is, universal biological underpinnings of musical processes within caregiver-infant vocal interaction may contain important prerequisite for humans' integrated healthy functioning, which are, in turn, prerequisite for later social development (see Figure 1). Thus, it is meaningful to acknowledge Darwin's seminal intuition of early associations between music and language, and to foster the spontaneous musical know-how that humans present from birth onward for later healthy development and the building of social relationships.

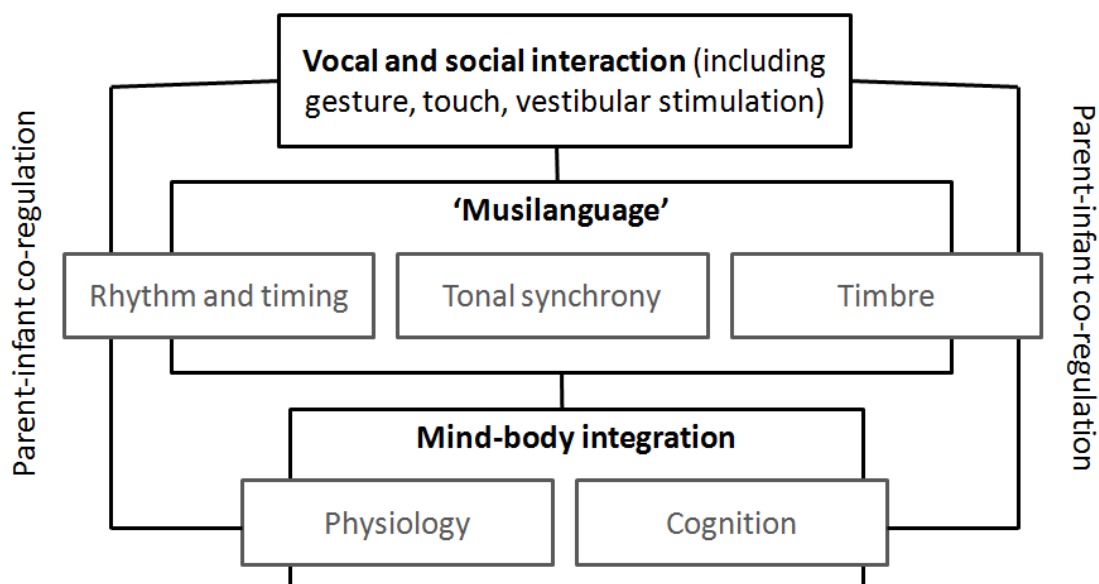


Figure 1. Hypothetical model of the ontogenesis of human communication

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