ON A MUSIC-READY BRAIN: NEURAL BASIS, MECHANISMS, AND THEIR CONTRIBUTION TO THE LANGUAGE EVOLUTION

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In the past decades, the concept of a 'language-ready' brain has stimulated language research from the perspective of evolution and development. However, parallels in research on the music-ready brain is still in its infancy (Arbib & Iriki, 2013; Seifert & Kim, 2006). To promote a comparison at the level of music- and language-readiness, we suggest beat induction as a promising starting point because it seems to be an important feature for every musical culture (Nettl, 2000) and this capacity is already available in newborns and therefore might be innate (Honing et al., 2009; Trainor & Corrigall, 2010; Winkler et al., 2009; Zentner & Eerola, 2010), but it is less pronounced in other primates (Honing et al., 2012; Zarco et al., 2009). The current paper is divided into two sections. In the first section, we propose four fundamental mechanisms for beat induction, namely hierarchical structure processing, auditory-motor coupling, prediction, and social interaction. Thus, we regard beat induction as an active process rather than a mere perception of auditory beats. In the second section, we discuss two approaches investigating evolutionary origins and neurocognitive mechanisms of beat induction. Their relation to components of a language-ready brain is discussed in terms of two (out of seven) criteria introduced by Arbib (2005).

One approach emphasizes the role of basal ganglia and dorsal pathway as well as the motor cortico-basal ganglia-thalamo-cortical circuit which give rise to the domain-general properties involved in beat induction and vocal learning, for example, prediction (Vuust & Witek, 2014) and auditory-motor coupling (Merchant & Honing, 2014; Merchant et al., 2015; Patel & Iversen, 2014; Patel, 2006). Concerning a component of the language-ready brain, these neural mechanisms are hypothesized to be involved in temporal sequence processing, i.e. mapping hierarchical structure to temporal order.

The other approach stresses mechanisms of social interaction as central to investigate the nature of beat induction (Fitch, 2012). We propose to extend the social approach by pointing out the relevance of social learning (Tomasello, 1996) with our Social Learning Hypothesis which claims that imitation-based social learning mechanisms which emerged on the scaffolding of mirror neuron systems shared with monkeys and apes are involved in beat induction. This hypothesis is in line with the view regarding music as primarily social domain (e.g. Overy and Molnar-Szakacs, 2009; Cross, 2011, 2012; Seifert et al., 2013) and is supported by studies of children in social contexts (e.g. Kirschner and Tomasello, 2009) as well as studies of non-human primates in interactive contexts (e.g. Konoike et al., 2012; Nagasaka et al., 2013). Moreover, the generation of auditory temporal prediction during sensorimotor synchronization recruits medial cortical areas (e.g. medial prefrontal cortex) (Pecenka et al., 2013), which is involved in social neural networks (Vogeley & Roepstorff, 2009). Concerning another component of the language-ready brain, complex imitation and its neural correlates in connection with mirror neuron systems is suggested to get more attention in future research on beat induction.

It is worth noting that our social learning hypothesis doesn’t deny the biological basis of the beat induction claimed by Honing (2013). Rather, it provides a new possibility to investigate biological foundations of beat induction and their relation to those of speech or language in the light of social cognition. An integrative approach of biological and social perspectives introduced in our paper provides important implications for the growing field of social cognitive neuroscience as well as cultural neuroscience (Han et al., 2013; Knoblich & Sebanz, 2008; Lieberman, 2007; Vogeley & Roepstorff, 2009), playing a significant role in research of language and music evolution.

Acknowledgements

Special thanks to Prof. Uwe Seifert and three anonymous reviewers for their helpful comments.

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