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How singing works

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A commentary on

Disorders of pitch production in tone deafness
by Dalla Bella, S., Berkowska, M., and Sowiński, J. (2011). Front. Psychol. 2:164. doi: 10.3389/fpsyg.2011.00164

Researchers have recently intensified their efforts to investigate the underlying neural correlates of music perception and processing (for an overview see Koelsch, 2011), music production, in comparison, has been studied rather sparsely.

The review article by Dalla Bella et al. (2011) on the other hand focuses on the cognitive and neural underpinnings of the human music production system that enables us to sing. Humans, as vocal learners, are not only capable of singing, but the authors point out that "singing is as natural as speaking for the majority of people." Indeed, the ability of vocal learning, i.e., to imitate our auditory environment can be observed extremely early in human development: Newborns' cry melody is influenced by the speech prosody of the surrounding spoken language (Mampe et al., 2009).

The review by Dalla Bella et al. (2011) defines the term "singing" and importantly categorizes and introduces us to several methods used to investigate singing. First, singing is an umbrella term for many different processes involving pitch production that differ in complexity: Pitch matching or repetition of tone sequences involve working memory to a different degree, whereas singing a well-known song requires the support of long-term memory. Second, there are different techniques to analyze singing, for example (i) the subjective rating of the singing output or (ii) the computing of an objective measurement of accuracy (deviation of produced pitch/interval from the target pitch/interval) and precision (consistency in producing pitch/interval). It is emphasized that different criteria – the type of singing as well as the analysis used – can lead to very different estimates of the ability to sing.

Mainly based on functional neuroimaging studies, the authors developed the vocal sensorimotor loop (VSL) model to explain the cognitive and neural processes underlying singing. The model depicts the interplay between memory components, motor and auditory sensory areas, and emphasizes the role of sensorimotor integration for human singing. The process of sensorimotor integration (Hickok et al., 2011) has also been observed during verbal working memory and speech production in humans (Hickok et al., 2003, 2011; Koelsch et al., 2009) as well as for singing in songbirds (Prather et al., 2008; Mooney, 2009).

Furthermore, research that investigated the influence of perception on singing is reviewed. Studies do not provide a consistent picture so far, but a dissociation between perception and production is suggested: Whereas poor-pitch singing and perceptual deficits are in general associated in congenital amusia, cases of spared vocal performance and a deficient pitch perception and vice versa cases of intact perception and poor-singing have been reported. In line with the latter results, there are reports indicating that some musicians with absolute (perfect) pitch, a rare ability to name tones, are similarly not able to sing perfectly in tune (for an overview see Takeuchi and Hulse, 1993).

An important aspect of the review is the question of how much the neural networks supporting music and language production overlap, especially because research has mainly focused on comparing the perception and processing between language and music (for an overview see Koelsch, 2011). The comparison of the production of language and music indicates so far, that speech production seems to involve a more left-lateralized network, whereas singing seems to rely on a more bilateral network. The authors present preliminary data suggesting that inaccuracy in pitch production does not extend to speech production in tone deafness, indicating that independent mechanisms are subserving imitation in music and language. An intriguing corroborating finding comes from a study investigating members of the KE family. The affected members of this family have an inherited speech–language disorder (verbal and orofacial dyspraxia) caused by a mutation of the FOXP2 gene, but they are not deficient in either the perception or production of pitch (Alcock et al., 2000).

To summarize, considering the importance of music for humans (Jancke, 2008, 2009; Koelsch, 2011), the review article by Dalla Bella et al. (2011) contributes to our understanding of human cognition by furthering our knowledge of normal and poor-pitch singing.

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