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Psychology of The Human Voice

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Abstract

Human voice is an identity feature which each person possess as unique characteristic and it gives information about the state or personality. It changes during lifespan and according to external stimuli, or because of bad use. Mechanism is very complex and not yet fully understood, because it involves several metabolic procedures that must work in cooperation: breathing, swallowing, laughing, whispering, crying, coughing or speaking, etc., being the brain areas overlapped in these functions. Across cultures and for different languages, basic voice emotions are recognized. Risings and fallings in intonation are activating different and/or opposite brain areas as well as and positive and negative expression of emotions.

Keywords: Voice; Speech; Feature; Trait; Premotor Areas; Laryngeal Motor Cortex; Broca Area; Rolandic Cortex; Central Gyri; Social Boundaries; Emotions; Across Cultures; Personal Information; Identity; Laryngeal Muscles; Singers; Music; Training

Introduction

Human voice is the sound produces when the air from the lungs vibrates the vocal chords in the throat. The larynx is the complex organ involves in this mechanism of phonation, breathing and swallowing. They involved a common laryngeal and esophagus integrative system which modulate the respiratory control, thought the swallowing function is not primarily controlled under cortical brain mechanism [1]. In nonhuman primates, vocalizations are controlled by subcortical regions [2]. Studies in monkeys have shown the cingulated cortex, periaquaductal/ gray pons and brain stem nuclei are involved in vocalization system. In humans affected by strokes in speech brain areas or with in vivo studies, several brain areas have been proved to be activated and or involved in vocalization and laughter: the dorsolateral frontal cortex, supplementary motor and auditory areas, the lateral hypothalamus, anterior cingulated nucleus, right putamen, left insula, parietal operculum, amygdale, limbic areas and right cerebellum [1-4]. In speech human articulation, the ventral pre and post central gyri are activated in the lateral sensorimotor (Rolandic) cortex [5].

Each voice is characteristic, a particular trait and different for each person, like the finger print. Nature and characteristic of human voice has been a mystery since many years ago: Leonardo da Vinci found and described how the airflow could animate the vocal folds of a cadaver to produce voice [6]. The porcine, canine and human vocal folds are very similar [6], however, the meticulous and thorough use of humans to create music or different languages is only typically human.

The expression of basic six emotions through voice in human beings and correspondence with consistent facial muscle movements have been proved to be equally recognized between different cultures [7,8]. Recognition of facial expressions for emotions is following a pattern in the brain (prefrontal and cingulated cortex) which resembles the mirroring action: brain premotor areas are activated six times greater in response to visual stimuli of facial movements of positive emotions (i.e. triumph and amusement) than those activation only to listening emotional vocalizations [9]. These mechanisms might be providing clues for a cohesive bonds generation between individuals inside a group for a better cohesion and survival of species, not only in primates [9]. In humans the hypothalamus triggers laughter, having an important effect over positive emotions: hamartomas (benign tumor) developing in the tubular part of the hypothalamus of children often lead to laughing seizures. Similar effects were found in aneurysm with bleeding within Willis´ circle [3].

For specific languages such as complex Madarin Chinese, it was found the rising tones in voice were activating the projections from the laryngeal motor cortex (LMC) to the left insula, right putamen and brainstem, but no activation happened with falling tones [4]. For speech understanding, the tones in languages and during singing are produced by an increase in the activity at the level of the laryngeal cricothyroid muscles (Figure 1). This activity is preceding the rises in fundamental frequencies of voice sounds [4].

Psychological and Biological Characteristics of Human Voice

Laryngeal dimensions are different between genders: the membranous vocal fold (VF) length, the cartilaginous VC length, the whole VF length, the VF width, the VF thickness, the height of the larynges are larger in men compared to women. Consequently, the acoustic properties and functions of the larynx are also different in frequencies, phonation, aerodynamic vortices, jitter, shimmer, sound pressure lever and signal-to-noise ration variables [6]. Also, body shape and size, emotional state and other variables are having an effect over the voice in the person and they are giving information about the characteristic of the speaker such as the state of fertility, attractiveness, age, etc. [10].

Production of a speaking, fluent speech and voice requires the coordinate movements of multiple articulators (lips, tongue, jaw, larynx, etc.). But also, in the brain, the specific areas of the language are activated (Broca, Rolandic cortex) and other areas of the sensorimotor cortex (central gyri) [5]. The whole speech might be differentiated in the cortex by three different clusters activation depending on sounds nature (vocal, consonant) and the oral articulator (labial, coronal tongue or dorsal tongue) [5].

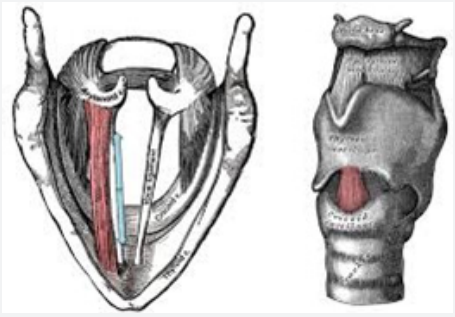

Figure 1: Visual representation of the human main muscles in larynx involved in prosody. Left: the thyroarytenoid (TA) and Right: cricothyroid (CsT) muscles.

Between singers (soprano, mezzo-soprano and contralto for women and countertenor, tenor, baritone and bass for men), the location of the larynx motor activation is different: activation peaks for the pitch level depends on their voice type and the tessitura, that is where their voice feels more conformable for the majority of the time [11]. Several muscles are involved in the speech prosody, which are the thyroarytenoid (TA) and cricothyroid (CT) muscles (Figure 1). They both work together and in interaction action over the range of frequencies and the amplitude of vocalizations [11]. Because they are muscles, plasticity and training over them by practicing and exercising is possible, but changes in voice tessitura are very difficult to get.

The neural representation of the various laryngeal muscles for human tones might be overlapped in the human brain, although they were all inside the larynx motor cortex (LMC) and not in adjacent orofacial somatotopic modules. Like concentric rings inside the same motor area some neurons are more activated according on how the person pitch level or peak activation and muscles more comfortably involves [11]. However, it is also possible the control of vocal pitch might be distributed between the two cerebral hemispheres.

Steroids are important for larynx anatomy and vocalizations. A study analyzed the changes in sexually dimorphic vocal characteristics of women during different phases of the menstrual cycle and they found the higher minimum pitch and lowest voice intensity happened during late follicular phase, suggesting more feminine voice during their fertile period. Other acoustic parameters were stable across the cycle while human communication seems to be more complex than vowel phonation [10]. Studies with animals have been done checking the vocal folds (VF) after steroids injections and they found in rabbits a difference in muscular atrophy and epithelial layer thinning continued until 12 weeks in injected rabbits. Steroids injections may induce several VF histological changes tested with hematoxylin-eosin staining [12].

Conclusion

Human voice is very informative about the speaker, its human characteristics and/or state-emotions. However, it can be trained as a communicative tool for improving precision in meanings or signals, in singers for the excellence in their performances or inside social interactions to express more accurately emotions across-cultures. Specific brain areas are activated for listening and/or speaking of language and they are unique and different from other species. Steroids are having an effect over acoustics characteristics in each person voice.

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