CALLS, WORDS AND BRAINS

ANONYMOUS AUTHOR 1*[1,2], ANONYMOUS AUTHORr 2[2,3], and ANONYMOUS AUTHOR 3[3]

*Corresponding Author: name@domain.com
[1]This Department, University X, City, Country

The discussion about the existence of compositionality in some nonhuman call combinations is seen as promising and enlightening by some researchers (Gil, 2023; Rizzi, 2016; Suzuki et al. 2016, 2019, 2022; Townsend et al., 2018; Zuberbühler 2019, 2020) while it is considered futile by others (Bolhuis et al., 2018a,b). Although stances differ within each side, the former contend that there is (some kind) of compositionality while the latter argue that there is none. In a recent argument denying the possibility of compositionality in nonhuman calls (Rosselló, Zhang, 2023) it is held that given the below definition of compositionality, which is at work in the field of animal research (see for instance Suzuki, 2016), it suffices to equate meaning with functional referentiality and take into account that (ii) presupposes (i) to deny the existence of compositionality not only in the two call combinations of Japanese tits —the best example of nonhuman compositionality provided so far— but wherever in nonhuman animal communication. Such an argument is new insofar it addresses (i) instead of (ii) and stronger than those based on (ii) because of the logical relation between (i) and (ii).

> Compositionality obtains when the meaning of a complex expression is determined by (i) and (ii)
>
> (i) the meaning of its parts
> (ii) the syntax combining them

The argument in question affirms that the alarm+recruitment call of Japanese tits does not fulfil (i) because recruitment calls are not functionally referential. The triad (sender, recipient, entity in the world) entailed by the notion of referentiality does not obtain. Moreover, it is predicted that no two call combination will ever be found insofar it is accepted that meaning in nonhuman animal communication amounts to functional referentiality. And that is so because no combination of functionally referential signals can be adaptive: it is impossible to escape from two predators of different kind simultaneously, look for food while escaping from a predator or forage two different kinds of food at once. One could argue that functional referentiality is a problematic construct. And we, in line with Fischer (2016), would agree. Yet, it happens to be the case that the claims of compositionality in Japanese tits go hand in hand with the acceptance of functional referentiality: "… calls are 'functionally referential' in that, like human words, they function [for the recipient] as if they represent objects in the external world." (Suzuki et al., 2019).

Despite its unclearness (see Fischer, 2016; Schlenker, 2023), functional referentiality has imposed some restraint in a debate whose terms are otherwise too undetermined as to be shed light on language evolution. We are then at the crossroads and the challenge is huge as the gap between calls and words seems unsurmountable: words are made up of discrete elements, arbitrary, learned via imitation, used intentionally, syntactically combined (with a merging asymmetry as a *red book* is a book and not a color), organized in open-ended lexicons, etc. Moreover, they are sort of a technological invention, a neural prosthesis not rejected by our ancestors' brains.

Progress will be made if we focus on how the brain supports words. Some facts to be presented in detail are the following: words, as sound-meaning associations, "reside" in the temporal lobe (pMTG) —unlike concepts that are everywhere. But they must be learned. Word learning requires vocal imitation and therefore sensorimotor integration. This task is mainly performed by the Arcuate Fasciculus connecting the temporal lobe with the frontal lobe. This connection is much weaker in nonhuman primates (Rilling 2008, 2023). Only in humans the Stp (Sylvian temporo-parietal) at its posterior end is an auditory-motor interface (Hickok, 2017) for vocal tract actions that in turn are made possible frontally by a direct cortico-ambiguus-laryngeal connection, which has an analog in song-learning birds (Jarvis, 2019) —and others. All this neural circuitry is left-lateralized (pre-)natally (Dubois et al., 2016). Nonhuman primates do not possess this neural circuitry (Buxhoeveden, 2001).

In sum, there is an evolutionary and biological explanation of how the human brain supports word learning and spoken language waiting to be completely specified. In the enterprise, animal behavior is relevant but to avoid getting stuck in unproductive debates, comparative neurobiology should take the lead.

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