**DO CHIMPANZEE PANT-HOOTS HAVE SEMANTIC CONTENT? A COMMENT ON
LEROUX ET AL. (*ANIM. BEHAV.* 179:41–50, 2021)**

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A comment on:

Leroux, M., Bosshard, A. B., Chandia, B., Manser, A., Zuberbühler, K., & Townsend, S. W. (2021). Chimpanzees combine pant hoots with food calls into larger structures. *Animal Behaviour*, 179, 41–50. DOI: 10.1016/j.anbehav.2021.06.026

Keywords: chimpanzee, animal communication, animal cognition, language evolution, food call, pant-hoot, semantic compositionality, syntax, vocal communication, food call

I read with great interest the study by Leroux et al. (2021) who investigated the nature of pant-hoot–food-call combinations in a community of wild chimpanzees (*Pan troglodytes schweinfurthii*) at the Budongo Conservation Field Station, Budongo Forest, Uganda. The authors propose, among others, that they reveal the first evidence that wild chimpanzees are able “to combine meaning-bearing units into larger structures” – i.e., that they are capable of semantic compositionality and, by extension, syntax (Hackl, 2013; Hurford, 2012; Kemp, 2013; Löbner, 2013; Saeed, 2016; Pagin & Westerstahl, 2019; Pelletier, 1994, 2016; Sweetser, 1999). Their analysis represents an important addition to a growing body of research and discussions on communicational combinatoriality in wild primates and specifically apes (Arnold & Zuberbühler, 2006a, b, 2008, 2012; Berwick, 2016; Bosshard et al., 2021; Clarke et al., 2006; Coye et al., 2015; Engesser & Townsend, 2019; Fitch, 2016; Girard-Buttoz et al., 2021; Haimoff, 1985; Inoue et al., 2017, 2020a, b; Jäger, 2016; Kuhn et al., 2018; Leroux & Townsend, 2020; Murphy, 2016; Ouattara et al., 2009a, b; Rizzi, 2016; Robinson, 1984; Sauerland, 2016; Schlenker et al., 2016a, b, c; Seyfarth & Cheney, 2016; Steinert-Threlkeld, 2016; Suzuki, 2021; Suzuki & Zuberbühler, 2019; Suzuki et al., 2020; Terleph et al., 2018; Townsend & Manser, 2013; Townsend et al., 2018; Zuberbühler, 2009, 2018, 2019), and, by extension, extinct hominins (Arbib, 2005, 2006, 2011, 2012, 2015, 2016a, b, 2017; Barham & Everett, 2020; Benítez-Burraco & Progovac, 2020; Botha 2020; Dediu & Levinson, 2013, 2014, 2018; Everett, 2017; Gabrić, 2021b, c, 2022; Gabrić et al., 2018, 2021a, b; Gil, 2008, 2009; Hillert, 2021; Jackendoff & Wittenberg, 2014; Michlich, 2018; Mufwene, 2013; Progovac, 2015, 2016, 2019; Vandervort, 2011, 2018, 2020). Incidentally, I have recently published a paper in *Animal Cognition* in which I also suggested, based on a reanalysis of existing data, that wild chimpanzees can display semantic compositionality and syntax, i.e., are able to combine

meaningful units (Gabrić, 2021a). In the present commentary, I argue that Leroux et al.'s (2021) interpretation of the data is ungrounded given that (1) unlike for food calls, there is currently very little if any indication in the scientific literature that pant-hoots have semantic content, i.e., are meaningful, (2) Leroux et al. (2021) did not investigate their *a priori* assumption that the observed pant-hoots are in fact meaningful/semantic, (3) they did not report on recipients' behaviors in association with neither the individual nor combined calls, and (4) they did not compare the callers' behaviours in association with the individual calls vs. combined calls. Since pant-hoots feature prominently in the chimpanzee vocal repertoire and the debate on their eventual meaningfulness/semanticity is still wide open, this represents a fine opportunity to revisit this issue in the context of Leroux et al.'s (2021) study. Their paper further raises several other less significant questions. Notwithstanding, their paper brings important novel insights into communicational combinatoriality in wild chimpanzees and supports the notion of using linguistic methods in wild animal communication research.

The evidence is increasing that specific vocalizations in a number of wild animal taxa can be described as semantic and word-like (Gabrić, 2019, 2021d; Gill & Bierema, 2013; Hurford, 2007, 2012; Macedonia & Evans, 1993; Seyfarth & Cheney, 2017; Townsend & Manser, 2013; Zuberbühler, 2009), including primate (Arnold et al., 2008, 2010; Arnold & Zuberbühler, 2006; Brumm et al., 2004; Cäsar et al., 2019; Cheney & Seyfarth, 1990; Digweed et al., 2005; Fischer, 2020; Lyn & Christopher, 2020; Schlenker et al., 2014, 2017; Snowdon, 2020; Struhsaker, 1967) and, specifically, chimpanzee and bonobo vocalizations (Clay & Zuberbühler, 2009; Crockford & Boesch, 2003; Slocumbe & Zuberbühler, 2005; Uhlenbroek, 1996). The most often described vocalizations involve alarm and food calls, where the vocalization means a specific predator or food type, respectively (Gabrić, 2019, 2021d; Hurford, 2007, 2012).

Unlike alarm and food calls, there is currently no consensus in the literature that pant-hoots are meaningful, i.e., have semantic content. Previous studies and discussions on pant-hoots have not tested or assumed that pant-hoots are meaningful/semantic. This includes previous papers by the authors themselves which were cited in the article (Engesser & Townsend, 2019; Fedurek et al., 2016; Hobaiter et al., 2017; Leroux & Townsend, 2020; Slocombe et al., 2010; Suzuki & Zuberbühler, 2019; Townsend & Manser, 2013; Townsend et al., 2018; Zuberbühler, 2009, 2018, 2019). Hugh Notman, one of few who has explicitly tackled the question of pant-hoot semanticity, proposed that pant-hoots “serve a generalized social function” rather than being “referential in the strictest sense of being arbitrary acoustic signals that symbolize external referents” (Notman, 2002, 2006; Notman & Rendall, 2005). In his study of communication in a wild chimpanzee community involving combinations of pant-hoots and drumming, Boesch (1991) mentions no possibility that pant-hoots are meaningful/semantic and that they contribute semantically to the following drumming sequences, which was my assumption as well when reanalyzing Boesch’s (1991) data (Gabrić, 2021a). In an analysis similar to Leroux et al. (2021), Boesch and Crockford (2005) also did not assume that pant-hoots are meaningful/semantic. Writing of pant-hoot and pant-grunt combinations by Tai female chimpanzees, they note that “the pant hoot part may announce [the female’s] arrival to the party”. Clark and Wrangham (1994) concluded from their analysis of arrival pant-hoots that they do not have food-associated semantic content but that they “mark status”. Falk (1999) has described pant-hoots as “a kind of protosinging and protomusic”, similar to Marler’s (1999) views of pant-hoots as “protomusical”, while Dessalles (2008) writes how pant-hoots “remain semantically opaque to [him]”. Arbib et al. (2008) compared pant-hoots to “a variety of involuntary vocal behaviors [in humans], but these are to be distinguished from speech”. There are many other examples of analyses and

discussions of pant-hoots where the authors make no assumption that pant-hoots are meaningful/semantic (Clark & Wrangham, 1993; Crockford, 2019; Desai et al., 2021; Jensvold et al., 2013; Luef & Pika, 2019; Riede et al., 2004) and pant-hoots do not feature in discussions on animal semantics (Egnor et al., 2006; Evans, 1997; Gabrić 2019, 2021a, d; Hurford, 2007, 2012; Suzuki, 2021; Vonk, 2020).

Thus, it is not particularly clear why Leroux et al. (2021) assume that pant-hoots are meaningful/semantic, especially given that they have not assumed this in their previous papers cited in Leroux et al. (2021). It is unfortunate that this assumption is made *a priori* and without reference to other literature, so there is no theory or data which could be discussed and used in support or *contra* Leroux et al.'s (2021) interpretations. Confusingly and critically amiss, Leroux et al. (2021) assert that their “compar[ison of] the fine acoustic structure of pant hoots and food calls given in isolation with the calls comprising the combination” “confirm[s] that the combination comprises individually occurring meaning-bearing units”. Such an acoustic analysis cannot, unfortunately, reveal whether a particular vocalization is meaningful/semantic or not. There now exists a history of experimental designs aimed at testing the eventual meaningfulness/semanticity of specific vocalizations in wild animals (eg., Seyfarth et al., 1980a, b; Suzuki, 2012, 2015, 2016, 2018, 2019) and semanticity of vocalizations may be inferred in observational studies as well (Boesch, 1991; Gabrić, 2021a), however, Leroux et al.'s (2021) study offers no data in support of the meaningfulness/semanticity of the observed vocalizations. Leroux et al.'s (2021) assumption is further vague as they propose no semantic content for the putatively meaningful/semantic pant-hoots. What do pant-hoots mean? With what kind of concepts are they associated? Leroux et al. (2021) merely write that pant-hoots “reliably encode caller ID”. Are they willing to propose that pant-hoots are similar to the semantic content of

proper nouns (i.e., individual chimpanzee “names”) or the personal pronoun *I*? Or did they fail to distinguish between semantics (meaning) of a vocalisation (e.g., LEOPARD; Seyfarth et al., 1980a, b; Struhsaker, 1967) and function of a vocalization (e.g., greeting, begging, etc.)? A clarification and potentially a revaluation of the interpretation is needed.

It is also notable that Leroux et al. (2021) also described neither the putative semantic content of food calls nor the semantic content emanating from the putatively semantically compositional call structure. Given that the meaning of a semantically compositional structure is, by its definition, a function of the meanings of its parts and the rule(s) applied to arrange the parts (Gabrić, 2021a; Hurford, 2012), it would be expected from a study on semantic compositionality that it will try to identify (1) the “derived” meaning of the semantically compositional structure and (2) the semantic relationship established between the combined parts, as has been done in other papers on semantic compositionality in non-human animals (Gabrić, 2021a; Hurford, 2012; Schlenker et al., 2016a, b, c; Suzuki et al., 2016). Furthermore, Leroux et al. (2021) investigated only the callers’ behaviors and did not investigate the recipients’ reactions to neither the individual calls nor the putative call combinations. It is difficult to discuss semantics when recipients’ behaviors are not recorded. The behavioural analysis was further constrained by exploring only the callers’ behaviours in association with the putative call combinations, making comparisons between behaviors associated with the individual calls and behaviours associated with the combined calls impossible. Such comparisons are needed without exception to determine the already mentioned “derived” meaning of the semantically compositional structure and the semantic relationship established between the combined parts.

Leroux et al. (2021) found that in these pant-hoot–food-call combinations, pant-hoots preceded food calls in 23 out of 25 cases. The authors use this as an argument for the possible syntactical

nature of these call combinations. However, before speculating about eventual syntactic properties of pant-hoot–food-call combinations, the authors should have first identified the semantic contents of the putatively combined individual units (*both* the pant-hoots and food calls) and the putatively semantically compositional structure. Given that this is not the case here and that there is little data available from the study, discussion on the eventual syntactic properties of the pant-hoot–food-call combinations may be premature (cf. Gabrić, 2021a). Even if the semantic contents of the individual units had been identified by the authors, too little data would still be available from the study. For example, we cannot tell from the data if the chimpanzees would react differently to the call combinations if they were faced with the “reverse” order of the combined calls (cf. Suzuki et al., 2016). A preferred order of vocalisations has been recognized for some other primate call combinations such as chirp–whistle combinations in cotton-top tamarins (*Saguinus oedipus*; Cleveland & Snowdon, 1982) and pant–chirrup combinations in titi monkeys (*Callicebus moloch*; Robinson, 1979; cf. Boesch & Crockford, 2005), yet these phenomena have been described as neither semantically compositional nor syntactic. Are Leroux et al. (2021) willing to propose that they are? Admittedly, however, at least one previous experimental study proposed that a preferred order in the combination of two individually meaningful units is suggestive of semantic compositionality and syntax but with a somewhat different repertoire of data (Suzuki et al., 2016).

Leroux et al.’s (2021) paper raises several other questions, unrelated to the semanticity of pant-hoots. Firstly, the authors restricted their analyses to sequences of pant-hoots and food calls where the interval between the two was not greater than two seconds. In one of the putative call combinations of Campbell’s monkeys (*Cercopithecus campbelli*), as identified by one of the paper’s co-authors Klaus Zuberbühler, there is a delay of some 25 seconds between boom and

alarm calls (Ouattara et al., 2009a; Zuberbühler, 2002). It is a shame that this point or, specifically, the inclusion criterion was not discussed further. This is also interesting, as at least one previous author has proposed that the relatively longer interval between vocalisations in the Campbell's monkeys suggests lack of semantic compositionality (Hurford, 2012), while semantic compositionality has recently been suggested for wild chimpanzees based on an analysis of combinations with an approximately two-minute interval between the individual units with arguments to the contrary (Gabrić, 2021a). Secondly, although their analysis of ecological factors associated with the pant-hoot–food-call combinations is informative, it would also have been interesting to analyse the associations with ecological factors of the individually occurring pant-hoots and food calls and to compare the results with the results for the pant-hoot–food-call combinations.

In conclusion, I argue that Leroux et al.'s (2021) interpretation about semantic compositionality are ungrounded given (1) there is no consensus in the literature that pant-hoots are meaningful, including (1a) the literature by the authors themselves which they cited in Leroux et al.'s (2021) and (1b) other literature, including by Hugh Notman, one of few who has directly discussed the semanticity of pant-hoots, (2) their pant-hoot semanticity assumption is made *a priori* and without reference to other literature, (3) they make no attempt to describe the putative meanings of the observed vocalizations (neither pant-hoots, nor food calls, nor the putative combinations), (4) they investigated only the callers' behaviors and did not investigate the recipients' reactions to neither the individual calls nor the putative call combinations, and (5) they explored only the callers' behaviours in association with the putative call combinations, making comparisons between behaviors associated with the individual calls and behaviours associated with the

combined calls impossible. Further, I find their interpretations about syntax premature independently of (1)–(5), given the paucity of their data.

Declaration of interest

The author has nothing to report.

Author contributions

The author confirms being the sole contributor of this work.

Acknowledgments

The content of the manuscript has previously appeared online as a preprint (Gabrić, 2021d).

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