

“Demonstratives and Primate Loud Call Frequency Variation”

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Introduction

In this paper, the possibility that an innate primate vocalization is embedded in modern human language will be explored. Non-linguistic vocalizations most certainly do exist in human speech, however, (Burling 1993, on screams and other gesture-calls). While the study of primate communication has become popular in recent years, human language is almost always singled out as a separate entity owing to its complexity. Furthermore, linguists have largely avoided non-linguistic cues in human speech, labeling them “peripheral”. As an attempt to fill this gap in study, primate loud calls will be compared to human language demonstratives. Both have been shown to be connected to spatial deixis, the distance away of the hearer or referent, and primate loud calls have been linked with variation in vowel frequency. A sample of human language demonstratives was taken and measured with regard to vowel quality. These vowel qualities are shown to be significantly related to distance, disagreeing with the notion that language is arbitrary. This result suggests that human language demonstratives show an identical variation to primate loud calls, and the former potentially derives from or otherwise bears relation to the latter.

The presence of non-linguistic vocalizations in human speech has been recognized, namely by Burling (1993), though its connection to symbolic language is contentious. In his article supporting a gesture-based origin of language, Burling distinguishes between various forms of non-linguistic

human communication. Symbolic gestures, verbal interjections, and onomatopoeias are grouped in a class of post-linguistic elements. In other words, sign language, *golly gee!*, and *cock-a-doodle-doo*, for example, all must have emerged from language, because they reflect a symbolic origin and are culturally transmitted. By contrast, the class of “gesture-calls” (Burling: 30) constitute non-symbolic, innate forms of communication. Gesture-calls according to Burling include elements like screaming, laughing, and smiling. These elements are clearly distinct from symbolic language in that they are reactionary as opposed to propositional, not easily manipulable, and not as changeable over time (Burling: 31). Subsequent work has supported Burling's claims. Facial expressions like smiling have been found to release endorphins in the person that performs the gesture (Schnall & Laird 2003). Laughter has been linked to a tickling-related gesture in great apes (Ross, et al 2009). Screaming is intuitively similar to primate alarm calls. Both constitute responses to threats, and primate alarm calls have been shown to operate on vowel frequency as does human speech (Fitch & Fritz 2006). Burling (1993)'s claims become contentious, however, with his relation of gesture-calls to speech: because gesture-calls still exist in human speech, language could not have evolved from them. Arguments to the contrary are numerous, as shown by the many comments in Burling's article. Wilcox (Burling 1993, Comments: 46) concludes that all language is gestural in function; language is simply more complex. Sakura (Burling 1993 Comments: 42) shows that the continued presence of gesture-calls does not preclude its relation to language, citing the presence of non-life among life (Cariani 1992). Lastly, Foster (Burling 1993 Comments: 39) asserts that language is not as entirely arbitrary, as Burling asserts (Burling: 33). Given these counterarguments, it seems possible that an earlier primate vocalization system could in fact remain embedded in symbolic language in some form.

Despite the many counterarguments to Burling (1993)'s conclusions, linguists and primatologists have neglected the study of gesture-calls embedded in symbolic language. In accounts of primate alarm calls, authors frequently refer to primate vocalizations as specifically separate from

human language (e.g. the first sentence of Mitani & Stuht 1998). This distinction represents the notion that non-human primate speech is specifically non-symbolic. As mentioned above, however, it would seem possible to compare primate alarm calls to human screams, though such a comparison is rarely made explicitly. Likewise, linguists largely ignored gesture-calls because they are not systematic in the same way as symbolic language. Chomsky, for example, went as far as to label these and other elements as “peripheral” (Chomsky 1986: 147), essentially declaring them not worth studying. The claim that language is arbitrary also prevents the study of any innate speech pattern. The “Bouba-Kiki effect” (e.g. Ramachandran 2001) has shown that speakers of different languages produce similar results when confronted with two shapes and asked to label them *bouba* or *kiki*. Nevertheless, studies of sound symbolism generally concentrate on one language as opposed to cross-linguistic patterns.

One linguist has provided evidence for the study of human gesture-calls, though his results are dubious. Rosenman (1982) attempted to reconstruct the original human language by comparing numerous languages across the world. Even according to himself, many consider that his methods “do not follow theory” (Rosenman: 304). Tellingly, his tomes are self-published (see, References). His results are intriguing, however, as many of the most easily reconstructed forms are these self-same gesture-calls like **ah* ‘universal sound of unhappiness, pain’ (Rosenman: 9). These data could provide the basis for further research into human gesture-calls like screaming, but few if any have studied these forms in particular, and most continue to entirely disregard the topic as a whole.

Background

While most insist that primate vocalizations lack the fundamental symbolic nature of human language (see van Heijningen et al. 2009, on this debate), research in recent decades has examined them more closely. This increasing corpus of primate vocalization research will provide the basis for

the study of human language demonstratives in this paper. Seyfarth, et al (1980) began the study of primate vocalization semantics with a study on vervet alarm calls. Seyfarth's results conclude that vervets classify the identity of the predator with one of three calls. Additionally, it is suggested that the calls are developed at least to some extent culturally, as the responses of juvenile vervets show more variation than those of adults. Subsequent authors have disagreed with the conclusion that vervets are communicating semantics (e.g. Burling 1993). It seems undeniable from this study, however, that vervets display a set of vocalizations, either discrete (as per Seyfarth) or on a continuum of sounds (as per Burling). These calls also produce a fairly consistent response from the hearer. Regardless of the extent to which vervets have symbolic language, these alarm calls seem comparable to human gesture-calls, which also exhibit a continuum of expression, for example, from sobbing to whimpering (Burling, 33). These calls also result in a fairly consistent response, though seemingly to a lesser extent than symbolic language. A similar pattern of predator-referencing call recognition has been observed in Diana monkeys (Zuberbühler 1999). Similar studies have also been performed on non-primate mammals. Chickens have been shown to react to the vertical height of a predator with a set of alarm calls (Evans et al. 1993). Squirrels seem to encode a predator's general proximity with their alarm calls (Leger et al. 1980). Other mammal vocalizations have been attributed more simply to emotional intensity, as shown by the reactions of *Megaderma lyra* bats to affect cues (Bastian & Schmidt 2008). These studies all demonstrate that primates and other mammals may exhibit a set of vocal calls similar to human gesture-calls. The particular semantics of each of these systems are all seen in human symbolic language: predator identity, vertical position, general proximity, and emotional intensity. It seems possible that a human pre-linguistic alarm call system accomplished some or all of these semantics.

From a phonological perspective, these aforementioned mammal vocalizations also seem to follow similar patterns of vowel frequency to human speech sounds. As mentioned above, Rhesus

macaques have been shown to recognize differences in conspecific call formant values (Fitch & Fritz 2006). Formant values refer to the resonant frequencies of particular vowels. For example, the vowel [i] has a high resonant frequency, while [a] has a low frequency. In Fitch and Fritz's study, Rhesus macaques did not dishabituate to recorded calls, which were then synthetically replicated by computers. They did dishabituate, though, to synthetic calls with modulated frequencies. This result suggests that frequency is a variable detected by humans and also non-human primates. Other aspects of vocalization, such as call rate, duration, and intensity have been analyzed in non-human communication. *Megaderma lyra* bats seem to react to call intensity (Bastian & Schmidt 2008). Ey et al. (2009) examines each of these aspects with regard to habitat absorption, assuming that calls must be heard in the midst of factors like forest vegetation, which may absorb the noise. Ey concludes that frequency and intensity are varied by individual olive baboons based on environmental conditions. Vowel frequency appears to be one of the most important factors of vocalization recognition and a venue for comparison between humans and other primates.

Research into non-human vocalization frequency has largely focused on three topics: species recognition, sexual selection, and distance contrasts. The first of these, species distinction, demonstrates that sound frequency is likely an innate element that evolves over time due to a variety of selecting factors. Burton & Nietsch (2010), for example, confirm the existence of a new cryptic species of Sulawesi tarsier based on recordings of duet songs from the wild. These recordings were analyzed based on frequency and duration, assuming that tarsiers with consistently different call sets constitute different species. This interpretation of the data has credence, as non-human primate vocalizations have not been shown to evolve new calls; the reaction to conspecific calls, however, may be to some extent culturally transmitted in vervets, as described above (Seyfarth et al. 1980). The variation in species call is attributed to a variety of potential factors. First, geographical boundaries such as the Tempe Depression and the isolation of one group to a different island explain

the lack of gene flow and subsequent development of new call systems. This same geographical separation results in distinct environments, which may provide the impetus for more specific call development, similar to olive baboons (Ey et al. 2009). Lastly, body size may result in the variation in call frequency. The picture of species differentiation is clearer with a study on wildcat subspecies (Peters et al. 2008). Measurements of six different species were taken with regard to body size, habitat, and call frequency. Body size proved to be an insignificant factor, but habitat was strongly linked to frequency, again due to levels of sound absorption. Studies of call frequencies in different species, thus, demonstrate that frequency and habitat are strongly related from an evolutionary standpoint.

Within a single species, call frequency is often linked to sexual selection as a contributing evolutionary factor. Fitch & Reby (2007), for instance, use frequency measurements to show that male red and fallow deer have evolved a descending larynx. Spectrogram analysis demonstrates that the deer's larynx drops while making a mating call in order to make a noise with a lower frequency. Fitch & Reby reject the hypothesis that this process developed in order to call longer distances, preferring the notion that it makes the male deer appear larger for the purpose of attracting mates. Ignoring the fact that humans do not display sexual dimorphism with respect to the descended larynx (often cited as a precursor to human language, evident in Fitch & Reby), they go on to suggest a similar development for human males and their deeper voices, which produce lower frequency sounds much like red and fallow deer. Despite the inaccuracy of this conclusion based on the deer data, Collins (2000) showed that human females equate deeper voices and lower frequencies with male attractiveness in a blind experiment. Sexual dimorphism, thus, may not have resulted in the human descended larynx, but frequency certainly seems to be related to male attractiveness. Lastly, Delgado (2006) considers the relationship between primate loud calls and sexual selection. Primate loud calls consist of long-distance vocalizations. Delgado conjectures based on the available evidence that

despite the long distance, primates seem to recognize individuals based on loud calls, and a relationship exists between loud calls and sexual selection. This evidence focuses on primates such as gibbons and orangutans; old world monkeys are discussed, though the results are less consistent. Nevertheless, sexual selection seems to have a connection with call frequency in various mammal species including humans and with loud call frequency in primates like gibbons and orangutans.

Lastly, several studies have related call frequency to relative distance of conspecifics. Mitani & Stuht (1998) provided the first examination of this relationship by analyzing a variety of non-human primate loud calls. Using a multivariate analysis, they take into account the phylogeny of the species studied along with body size and the size of their home range. The variable that most strongly correlates with the measured call frequencies was determined to be home range size; body size and phylogeny were found to be insignificant. With these results, it is acknowledged that lower frequency also alerts a larger number of predators to the caller's location, and no further hypotheses are given due to a lack of corroborating evidence. A second study, Ey et al. (2009) focuses on habitat type. Ey demonstrates that individual female olive baboons modulate call frequency and duration depending on their location in open or closed habitats. Lower frequency and higher duration were both evident in closed habitats, likely to aid in sound propagation, due to the dense vegetation that may absorb sounds. By contrast, calls were shorter, had a higher rate, and higher frequency in an open habitat. Ey admits, however, that these effects may also be due to the proximity of other group members, which also correlate with habitat type. In a third study, Sugiura (2007) observed the interplay between call frequency and duration, and proximity to group members in Japanese macaques. The picture of these results is clearer: larger frequency modulation and higher duration correlated with lower proximity to other group members. Factors such as habitat and the specific activity of the group were not related. Distance to other group members, thus, represents an important factor in call frequency variation throughout the Primate order.

Research on primate vocalizations as a whole suggests that call frequency is evolutionarily correlated with factors such as sexual selection, habitat variation, and proximity. These relationships will provide the backdrop for the following study of human language. Since modern humans exist in very different environments from one another, habitat variation will be disregarded for this study. Additionally, because most languages are encoded with the same grammar for both genders, sexual selection will also be left aside. General proximity, however, is encoded in many languages in the form of demonstratives, such as *this* and *that*. Particularly following the conclusions of Mitani & Struht (1998), Ey et al. (2009), and Sugiura (2007), it will be hypothesized that humans could have displayed a call frequency variation before the origin of symbolic language. Also assuming that such primate call systems are innate, this frequency variation should continue to be evident, at least secondarily in symbolic language. While this connection would not provide much evidence for the evolutionary factors underlying the development of language or of call systems in general, it could provide a clearer picture of pre-linguistic human communication.

Methods

In order to study human language demonstratives, data from a wide selection of languages was assembled and analyzed with respect to vowel. The data set was taken from Diessel (2005)'s analysis of demonstratives in the *World Atlas of Language Structures*. Diessel collected complete demonstrative paradigms from 234 languages across the world in order to analyze the geographic distribution of the number of distance contrasts. In languages like English, there is a two-way distance contrast between *this* (proximal) and *that* (distal). Other languages like Spanish have a three-way distinction between *este* 'this (proximal)', *ese* 'that (medial)', and *aquel* 'that (distal)'. Most languages have two- or three-way distinctions. 7 languages had no distance marking, and 12 displayed four or more categories. These 19 languages were discarded in this study owing to a lack

and preponderance of information, respectively. In the remaining languages, which number over 200, the vowel quality of the proximal and distal forms was tracked, specifically with regard to vowel height.

Analyzing this data is wrought with a number of potentially confounding variables and inconsistencies. First, the demonstrative forms were gathered from a huge variety of sources, which may have conflicting phonological or grammatical information. For example, the Maori proximal form is cited as *teenai* from Bauer (1993), though other sources such as Harlow (2007) list the same form as *teenei*. As another example, French is listed as having no distance contrast, though the postclitics *=ci* and *=là* may be added to nouns to mark proximal and distal function, respectively. Despite these potential inconsistencies, it will be assumed that each form is referencing an expert in the language, and that more detailed analysis would take considerably more effort.

As a second complicating factor, demonstrative forms are often more complicated than a single vowel. For a simple example, English *this* and *that* differ in the vowel and final consonant. Based on these forms alone, it is equally possible that the consonants are responsible for differentiating between proximity and distance. Other forms are much more complicated. In Upriver Halkomelem (Salishan: Canada, United States),¹ the three demonstrative forms are: *təʔi:ləʔə*, *təθék^wθə*, and *təʔi:tik^wə*. In these cases, some measure of morphemic analysis was performed when possible. In this case, the *tə-* element is clearly a prefix and the *-k^w(θ)ə* element is a suffix, leaving forms with the [i], [ɛ], and [i] vowels, respectively. By just tracking broad vowel height, these forms are listed as high, mid, and high, indicating their relative frequency. Most forms were straightforward, however, even consisting of single vowels in some languages. The three demonstratives in Tümpisa Shoshone (Uto-Aztecan: Southern California) in particular follow the predicted pattern: *i-*, *e-*, and *a-*.

As another potentially confounding variable, languages may be phylogenetically related, resulting in similar forms. While this is a possibility, there is a considerable number of unrelated

language families attested in this sample, and the number of related languages would not be large enough to make a significant impact on the data. While it is possible that all languages are related on some level, the number of sound changes and grammatical developments renders it extremely unlikely that these forms would retain a certain sound according to standard linguistic development. Furthermore, demonstratives are known to grammaticalize, or develop into other forms like copulas, conjunctions, and relative clause markers (Heine & Kuteva 2002). All in all, if one sound is present in a high number of demonstratives, it seems certain that it would be due to a factor other and regular language change.

Having tracked vowel height for the demonstratives of over 200 languages, the results were collected and preliminarily synthesized. The null hypothesis for this data is that the vowels ought to be randomly distributed throughout both proximal and distal forms. Even if one vowel were more frequent than another cross-linguistically, this pattern would be detected by a lack of variation between the two sets of data. If the data shows a predilection towards a high vowel² [i] in proximal demonstratives and a low vowel [a] in distals, a possible connection with primate loud calls would be suggested.

Results

Chart 1 below gives the counts of each form and their respective *p*-value following a basic Chi-Square test. Initial results reject the null hypothesis and very strongly suggest that there is a correlation between the high [i] vowel and the proximal demonstrative; and the low vowel [a] and the distal. There is also a significant negative correlation with the high, rounded vowel [u] and the mid, rounded vowel [o] in the proximal demonstratives, and a weakly significant correlation between [u] and the distal.

vowel	Proximal	<i>p</i> -value	Distal	<i>p</i> -value
high [i]	77	< 0.0001	26	0.2857
mid [e]	48	0.9217	29	0.5379
low [a]	52	0.6466	100	< 0.0001
mid, round [o]	19	0.0144	25	0.2189
high, round [u]	13	0.0005	21	0.057

Chart 1

Discussion

Despite the potential inconsistencies and confounding variables in this study, the results provide very strong evidence that regular language change does not account for the vowel quality pattern seen in human language demonstratives. While modern human language is largely symbolic and therefore arbitrary, demonstratives are significantly not arbitrary. This notion makes some measure of sense in that demonstratives are not content words or words with a symbolic mental representation; they are more related to exclamations.

These connections may be explained diachronically. In the *World Lexicon of Grammaticalization*, Heine and Kuteva (2002) describe established patterns of lexical development over time. For example, the content noun for 'home' has become a locative, a grammatical case marker indicating location, in some African languages like Susu (Mande: Guinea, West Africa) (Heine & Kuteva: 174). These grammaticalizations often make semantic sense. For instance, home is often where a person is inherently located. Demonstratives, according to Heine & Kuteva, often evolve from words meaning 'here' and 'there,' and subsequently develop into other forms like copulas, conjunctions, and relative clause markers. Mysteriously, there is no recognized grammaticalization path to 'here' or 'there'. It seems possible that an existing human proximity-based vocalization system could provide the origin for 'here', 'there', and demonstratives. While more research is needed to fully

explore human screams, a person might cry *Eek!* if a mouse is proximally at their feet, while they may cry *Aaahh!* if they are crying for help to someone far away. A mouse may not be a predator per se, but such a connection does not seem impossible. This grammaticalization path could in theory explain the pattern of vowels. Indeed, the aforementioned Tümpisa Shoshone *i-* and *a-* demonstratives could be examples of recent grammaticalization.

These results also contradict Burling (1993)'s conclusion that symbolic language is distinct from gesture-calls. Surely these hypothetical proximity-based vocalizations are as innate as those of other primates. Nevertheless, given the above hypothesis, these gesture-calls themselves participate in symbolic language. While it is difficult to definitively comment on human proto-language, it seems entirely possible that processes like the grammaticalization path of gesture-calls to demonstratives could reflect how language evolved from an earlier primate vocalization and gesture system. Certainly, gesture-calls could affect modern language in many other ways that are as yet undetected, and still other paths could have occurred at one time in the past, but are no longer productive. Of further note, if gesture-calls naturally grammaticalize into symbolic language, it is implied that the two systems are compatible, possibly revealing an inherent symbolic nature of primate vocalizations or an inherent gestural nature of symbolic language.

All in all, this statistical study of human languages around the world demonstrates that human gesture-calls may interface with modern symbolic language, and that humans may retain a proximity-based gesture-call system related to other similar primate vocalizations. Both human demonstratives and primate loud calls have been shown to exhibit vowel frequency lowering over increased distance. Human demonstratives are of course referential in nature, but a significant preference for high and low vowels suggests an inherent link between demonstratives and loud calls. As a possible scenario, humans could have taken to an open habitat and developed a need to call group members at various distances either because of the presence of predators or to call attention for other reasons, such as

ming. Following the development of symbolic language, humans could have retained this system, but are not cognizant of it because of its innate, subconscious nature.

Further research is needed in many aspects of this study. The presence of such a proximity-based system must be tested cross-linguistically. Also, the extent to which this system is innate or culturally transmitted may provide a glimpse into similar primate vocalization development. Lastly, other grammaticalized forms may show similar developments. For example, vocatives, or forms of address, are often composed of a mid-vowel [e] or [o], as in Latin *-e* or Middle English *O!*. Additionally, there is a very strong tendency for demonstrative forms marking non-visible referents to have a rounded [u] vowel.

Endnotes

1. Languages are referenced in the form of (Language family: Area spoken).
2. “High” and “low” refer to the relative frequencies of human vowels. [i] is considered a high vowel, and [a] a low vowel. Lip rounding is also indicated, as in the high, rounded vowel [u].

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