# THE ROLE OF RITUAL IN THE EVOLUTION OF LANGUAGE AND THE EMERGENCE OF RECURSION

ROBERT KLUENDER[*1] and EMILY DAVIS[1,2]

[*]Corresponding Author: rkluender@ucsd.edu
[1]Department of Linguistics, UC San Diego, La Jolla, CA, USA
[2]Centre for Language Evolution, University of Edinburgh, Edinburgh, Scotland

Human language presents a unique conjunction of referential and structural properties, the combined evolution of which is hard to account for. Here we synthesize older linguistic theories on the ritual origins of language with newer experimental results to present an exaptive account of both referential and structural aspects of language (particularly center-embedding) in ritual contexts. We discuss our current ongoing work using iterated learning tasks to elucidate the conditions under which novel center-embedded structures emerge, and conclude with a more general proposal for closer coordination of the language evolution research interests of anthropologists, ethologists, biologists and linguists in the study of ritual.

## 1. Introduction

One of the enduring conundrums for language evolution proposals is the thorny issue of how to account for the emergence of complexity on multiple, distinct yet interconnected levels simultaneously – or for that matter, even sequentially. Our goal in this paper is to highlight, revive and argue for the viability of language evolution proposals offered by linguists in the 1980s based on properties of animal and human ritual. We rely on commonalities outlined in Tonna et al. (2019) to generalize across animal and human ritual in this way: repetitive, sequential action chains in response to unpredictability, with emphasis on formal structure, precedence of exactitude of performance over any originally intended functional goal, and promotion of communication/bonding. Our main argument is that linguistic ritual-based proposals such as these offer plausible scenarios for the simultaneous development of both the crucial referential and structural properties of human language, especially recursion. We further investigate the claim that center-embedding is ubiquitous in human and animal ritual, as well as within the cognitive capacity of non-human species, and describe our progress thus far in

trying to tease out experimentally the conditions under which center-embedding in particular might emerge. Finally, we highlight the prospects for more closely coordinating the study of the role of ritual in the evolution of language among social and cultural anthropologists, ethologists, biologists and linguists alike.

## 2. Brandon & Hornstein (1986)

Brandon & Hornstein (1986) proposed a three-stage scenario for the emergence of arbitrary symbolic reference from iconic systems of representation, via a process of ritualization in non-human animal species. The first stage occurs on the part of the receiver: an organism begins to treat the functional action of another organism, or a part thereof, as a sign of the action itself. For example, the functional movements necessary for initiation of bird flight (crouching, raising the tail, spreading the wings) can be interpreted causally by one bird as an indication that another bird intends to lift off. The second stage involves the sender accentuating and stylizing a behavior beyond its basic functional requirements in order to signal intention to a conspecific, which then interprets it as such. For example, Lorenz (1977:211) reports that pigeons exaggerate preflight behaviors in order to facilitate coordination of flight behavior with conspecifics within the same flock. In the third stage, a stylized behavior is displaced (in the ethological rather than the referential sense) from its source domain into a new sphere of activity. Bird courtship displays frequently incorporate stylized feeding and/or nesting behaviors, and primate displays that regulate social relations within a hierarchical dominance structure often incorporate stylized sexual behaviors.

Tomasello (2008:23) proposed ontogenetic versions of the same three-stage ritualization process. A displaced behavior can thus begin to look arbitrary to the outside observer – and possibly to the individual animal – as the original connection to the source domain or context is lost over time. If the connection can only be recovered through historical reconstruction, then for all practical purposes it becomes arbitrary in nature. Brandon & Hornstein (1986) speculate that this is a pre-adaptation for the emergence of purely symbolic representation.

## 3. Staal (1979, 1980, 1984a, 1989)

In a series of papers appearing in relatively obscure journals and anthologies (Staal, 1979, 1980, 1984a), and in a subsequent book (Staal, 1989), Frits Staal, a philosopher of language, linguist and Sanskritist, made a number of revolutionary claims about the evolution of language, based in particular on his study of Indian ritual. His views were informed by his observation and extensive documentation of a rarely performed twelve-day Vedic rite undertaken in 1975 in Kerala, a state in the deep southwest of India, where the ancient Vedic tradition that predated

Hinduism has been more prodigiously preserved by the priestly class than elsewhere on the subcontinent.

Staal's basic thesis is that ritual and the behaviors (and in the case of human ritual, even the language) associated with it are essentially meaningless. Like Brandon & Hornstein (1986), Staal (1979:12-13) argues that subsequent to displacement of particular behaviors from a source to a target domain in animal ritual, they lose their functional significance. While there may still be an expected outcome involved in rituals, even human ritualistic activity persists beyond the point at which the original motivation for it has become lost or is no longer valid (e.g. "eternal" flames). Staal (1979, 1984a) further argues that while ordinary activity focuses on results, ritualistic activity is focused solely on the correctness of performance. Anyone who has seen nature films of the courtship displays of bowerbirds can attest to the fact that there is extreme pressure to perform to acceptable standards – with severe selective consequences if those targets are not met – even in animal ritual.

Staal (1979) therefore concludes that the hallmark of ritual is its rule-governed nature. This leads to his further conclusion that it is the *structure* of ritual that matters far more than its purported content. His analysis of Vedic ritual demonstrates that it exhibits properties of both complementation, in the form of embedded sequences, and modification, i.e. sequences that undergo various changes in different contexts. In other words, it has the properties of a syntactic system. Staal goes on to hypothesize that the syntax of language was exapted from the syntax of ritual. Note that this proposal is not all that different in kind from that of Hauser, Chomsky, & Fitch (2002:1578) who speculate that the recursive properties of language could have been exapted from domains of animal behavior other than communication, such as navigation, numerosity, or social cognition.

However, Staal (1980) points out that ritual exhibits only center-embedding rather than right- or left-branching recursive structures. He suggests that since ritual unfolds on a much longer time scale than human language, there are no intrinsic working memory constraints on the use of center-embedding in ritualistic contexts, which seems plausible. He also suggests that the limited occurrence of center-embedding in human language may be a remnant of its unrestricted use in ritual. We suggest here that Staal might have actually taken this argument further.

The problem with the evolution of syntax has always been what the seed could be that would precipitate the emergence of structure in a relatively unstructured referential system. Staal's account already provides this seed via exaptation from ritual contexts. But once center-embedding has been established as a structural principle, it seems to us that its evolutionary transmogrification into right- or left-

branching structures should be a fairly trivial matter. The virtually impossible center-embedded sequence (1) can easily be rendered transparent as (2).

(1) The woman [the man [the host knew __ ] brought __ ] left.
(2) The host knew the man [who brought the woman [who left]].

Yet this seems to be more of a referential (i.e. similarity-based interference) than a syntactic problem anyway, since changing the nature of the discourse referents renders even the use of center-embedded syntax transparent (Bever, 1970):

(3) The woman [someone [I knew __ ] brought __ ] left.

Note that Brandon & Hornstein's (1986) account of how symbolic reference could have emerged as a result of the ethological displacement of animal behavior from one domain to another in ritualized contexts provides an avenue for the referential properties of language to develop simultaneously and in parallel with syntactic properties of recursion via one general process of exaptation. To our knowledge, this is the only exaptive scenario that has this two-for-the-price-of-one advantage.

The next obvious question, however, is whether there is adequate evidence for center-embedding not only in forms of everyday human ritual less elaborated than complex Vedic rites, but also in animal behavior. We turn to this question next.

## 4. The evidence for center-embedding in human and animal behavior

### *4.1. Human ritual*

Center-embedded sequences are more common in contemporary, everyday human ritual activity than may be apparent at first blush. Pulvermüller (2014) demonstrates how something as trivial as the quotidian ritual of toothbrushing can plausibly be analyzed as having up to ten layers of center-embedded action sequences, each consisting of matching starting and ending actions: e.g. taking out a toothbrush and putting it back into its holder, or opening and closing a door. Many formalized human ritual activities also exhibit this so-called ABA structure, in which a sequence is bracketed off by matching components at its beginning and end. Portions of the traditional Christian liturgy are in ABA form, notably the *kyrie*, and also the *hosanna* portion of the *sanctus*. Staal (1984b, 1989) points out that many traditional musical forms have an ABA structure: rondo, minuet, and the sonata form derived from them. More complex palindromic forms are also found in the classical music repertoire, e.g. ABACABA was a common form of the rondo during the classical period, and Staal cites sequences as baroque as ABACABACABA and ABCDEDCBA in Bach's compositions. Interestingly, Senghas, Kita & Özyürek (2004) also reported the use of ABA structure to express

relations of simultaneity in one third of their Nicaraguan Sign Language participants, regardless of cohort. In any event, the degree of center-embedding in ritualized human activity, as Staal observed with regard to more intricate, longer Vedic ritual performances, likely antedates and informs its use in language.

### *4.2. Animal ritual*

There is also some limited evidence for simple ABA center-embedded structures in animal behavioral rituals, i.e. a central action bracketed by two identical or matching actions. For example, greeting rituals between male baboons (Smuts & Watanabe, 1990; Whitham & Maestipieri, 2003; Dal Pesco & Fischer, 2018; see also Colmenares, 1990, 1991) have a quasi-palindromic structure: one baboon approaches another with obvious intent, performs the greeting, and then retreats. The courtship dances of great crested grebes, as discussed by Staal (1984a), also show elements of this structure: the birds shake their heads, pick up water-weed, present it to each other, drop it, and then shake their heads again (Huxley, 1914:26ff). Interestingly, this behavioral bracketing of animal ritual sequences is mirrored by increased neuronal firing at the start and end of learned action sequences in the striatum of rats (Jog et al., 1999; Barnes et al., 2005) and the prefrontal cortex of macaques (Fujii & Graybiel, 2003).

### *4.3. Animal artificial grammar learning*

Independent of Staal's claims, attempts have been made to ascertain whether other animals can learn the recursive grammatical rules necessary to interpret or produce center-embedded sequences. The finding of Gentner et al. (2006) that European starlings can learn center-embedded auditory strings of the form $A^nB^n$ up to n = 3 (i.e. AAABBB) could also be accounted for by a finite-state grammar augmented with a counter (Rogers & Pullum, 2011:339). But center-embedding rules are unambiguously required to form or interpret palindromic sequences (e.g. ABCBA), and there is evidence that both songbirds (Abe & Watanabe, 2011) and macaques (Jiang et al., 2018) are able to recognize and complete such sequences.

## 5. Iterated learning and the emergence of center-embedding

In a series of non-linguistic iterated learning experiments, we set out to determine under what conditions center-embedded structures might emerge in sequences of pictorial icons. Two factors were manipulated. First, initial stimuli consisted of strings in which all icons were either entirely distinct, or else contained two non-adjacent identical icons, which could be understood as forming a dependency. This manipulation was designed to test the hypothesis that the existence of long-distance dependencies in the input stimuli might serve as a necessary precursor for the emergence of center-embedding (Pullum & Rogers, 2006; this is also

consistent with the results of Abe & Watanabe, 2011, cited above in 4.3). Second, icon sequences were either presented simultaneously in a block, or sequentially one by one in RSVP mode. This was designed to test whether working memory constraints might facilitate or impede the emergence of center-embedding.

Thus far we have been able to establish two basic facts: (1) the repetition at a distance of icons in the initial input string does indeed facilitate the emergence of center-embedding, which (2) occurs to a greater degree under the additional working memory burden of sequential presentation. However, while center-embedded structures did appear over ten generations of transmission, they did not appear at levels greater than chance. Additionally, a follow-up experiment has shown that if input strings contain center-embedded structures (i.e. palindromes), this structure disappears in transmission, indicating that center-embedding is by itself neither a preferred nor an advantageous feature for the learning and transmission of strings, consistent with decades of psycholinguistic research.

## 6. Conclusion

We have resurrected and argued for the potential advantages of linguistic proposals for the evolution of language based on the scientific study of animal and human ritual. These proposals existed on the fringe of research in the 1980s, and have been largely forgotten today. To the extent that ritual has been a major focus of language evolution theorists, it has been primarily the domain of cultural and social anthropologists, or biologists and ethologists. Yet their conclusions are largely consonant with those of linguists: structural form predominates over content in human ritual (Lewis, 2018; Merker, 2005, 2009). Our goal here has been to help bring linguistic studies of ritual back into the mainstream of thought on language evolution, because it seems to us that they offer the possibility for the simultaneous evolution of crucial referential (i.e. arbitrary symbolic reference) and structural properties (i.e. recursion in the form of center-embedding) of language in tandem – but also possibly independently of each other – within the same general model. We therefore advocate a general research framework for addressing these questions going forward. We are focused on the question of recursion in the form of center-embedding and its emergence in human language, given its status as the apparent *sine qua non* of language evolution (Hauser, Chomsky & Fitch, 2002). However, an equivalent focus should be directed to the emergence of arbitrary reference and duality of patterning. Our suspicion and hope is that a general research agenda of this type could help to coordinate and align more closely the important research on language evolution of anthropologists, ethologists, biologists and linguists, to the overall benefit of the field as a whole.

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