In their article *Language as Shaped by the Brain*, Christiansen and Chater (henceforth C&C) argue, from an evolutionary perspective, that the rapidity involved in a child’s acquisition of its first language is due to languages adapting to the brain, rather than vice versa (as typically argued by proponents of UG). In particular, a point of view is adopted which takes natural languages as akin to biological organisms, engaged in an evolutionary competition to find the best fit to the domain-independent learning and processing biases manifested by the human brain, while at the same time retaining as much expressivity as possible. A logical consequence of such a view is that whatever kind of structure may be found to underlie language, its motivation should ultimately be derived from functional considerations: no amount of innate genetic endowment specific to human languages is postulated to exist by C&C. They therefore propose a notion of linguistic universal alternative to the strictly formal kind adopted by proponents of UG-based accounts: rather than being omnipresent cross-linguistically, a universal is taken to reflect a statistical trend arising out of the interactions between constraints governing such diverse cognitive domains as thought, the perceptuo-motor system, pragmatic sources and cognitive limitations on learning and processing (a statement taken quite literally from the penultimate paragraph of p. 33); in other words, general properties of human cognition. It is particularly in relation to the authors’ suggestions on the role of thought processes (pp. 34-35) where I wish to make my contribution.

C&C proceed from several assumptions rooted in analytic philosophy that I shall here repeat for the sake of clarity and subsequently adopt myself: (i) thought may be studied through an analysis of such linguistic units as (say) sentences or discourses and the patterns of inference to which these find themselves subject; and (ii) thought precedes, and is independent of, linguistic communication. The statement towards which I shall take a critical stance concerns the mapping (assumed by C&C to be made available by language) of (mental representations of) thought into phonology. From (ii), it follows that this mapping may manifest properties inherent to the structure of thoughts that language serves to express (thus guaranteeing a functional motivation for these properties), such as adherence to compositionality or the manifestation of function-argument structures. However, the authors also claim this mapping to ”surely” be specific to communication, since, ”after all”, inferences ”presumably” target only the representations of thought rather than those of phonology or syntactic trees. I do not share this latter conviction. Although in such standard calculi as classical, intuitionistic and minimal sentential logic, inference is indeed modeled as a relation between sets of propositions, there exists a substantive amount of research on consequence relations over richer structures of formulae. In fact, even as far back as 1958, Lambek ([5]) already proposed a calculus of syntactic types, essentially a logic over strings, with binary-branching hierarchical structures considered in a follow-up article in 1961 ([6]). In light of these achievements, I will reason below that the thought-phonology mapping need not be so specific to communication as C&C claim it to be, arguing instead the influence of communication to be of a more subtle nature. In doing so, I will crucially not have to postulate the existence of any language-specific machinery within the brain: the general argument concerning the relation between language and the brain and the functional motivation of linguistic constraints is not touched upon (i.e., my claims cannot effectively be used to argue against this more general program initiated by
C&C).

The structure of the argument shall be as follows. First, I will provide a short elaboration of the view on linguistics shared by the family of categorial grammars\(^1\) inspired by Lambek’s research (often referred to as *categorial type logics*, or CTL for short). Second, I reconsider the contribution of communication in shaping the thought-phonology mapping, arguing this to be of a more marginal nature than is assumed by C&C. As a by-product, this discussion may be seen to contain a recipe for rendering free CTL from any ontological commitments related to the existence of innate language-specific machinery. I conclude with a discussion of Minimalism, the framework in relation to which C&C found themselves compelled to state the particular claim against which I argue.

The main insight entering into the class of categorial type logics extending Lambek’s original calculi is as follows: the formation of syntactic units (trees for instance) reflects directly the structure of inferences. More in particular, it is claimed that operations constructing larger syntactic units, or deconstructing them again, are rules of inference, thus reducing the problem of deriving (or the more general process of parsing) a sentence to that of finding a proof of its well-formedness. The interface between the mental representations of thought and their external phonological realization then obtains by virtue of the Curry-Howard isomorphism (or its weaker homomorphic variant), subsuming the concept of compositionality.

If indeed the various technicalities entering into the formation and comprehension of syntactic structures reduce to proof-theoretical machinery as categorial type logic holds it, then the thought-phonology mapping already arises less communication specific than C&C argue it to be: its structure is a direct reflection of that of mental inferences. However, claiming language to be a logic immediately leads us to question why it is the particular logic that it is. It is in the solution to this dilemma where I shall argue considerations stemming from the communicative function of language may still enter. The first step towards this conclusion consists of the insight, due to Gabbay ([4]), that there exists a procedure for obtaining proof calculi for a wide array of substructural logics (among which we count the various Lambek calculi and their generalizations) from the rules of inference characterizing ordinary classical logic. Intuitively, Gabbay considers a labelling device for the formulae operated upon by these rules, allowing him to parameterize over the particular structures in which these formulae are organized (be it a set, as in the standard logics, or a multiset, a string, a binary tree structure, etc.). Hence, the inferential laws characterizing categorial type logics are derivable directly from those governing classical reasoning, subject to which I take to be, at least in part, the inferential patterns of thought (no doubt a simplification of the actual state of affairs). What remains, then, is the need for a precise characterization of the type of structures reasoned with by language. Rather than postulating this to be innate, we find that it may alternatively be motivated by appeal to the processability of languages (and perhaps also their learnability), which is clearly related to their communicative function. For why develop a specialized logic for language at all? Why do we simply not communicate through some standard variant of propositional logic? Surely the constructive variants already allow for a surprisingly large amount of expressivity. But recall in this respect C&C’s more general claim regarding the evolution of languages: expressivity is but one parameter by which the evolutionary fitness of a language is measured; it should also be interpretable, or processable, by the human brain. Now it is widely known that already the implicational fragment of minimal propositional logic is PSPACE-complete, rendering it unsuitable for this purpose (although, admittedly, smart algorithms exist for rendering large fragments of classical propositional logic decidable in PTIME, see [3]). On the other hand, a recent result by Moot ([9]) shows that the Lambek-Grishin calculus ([8]), itself a variant of CTL, is mildly context-sensitive, implying compatibility with a limited variant of cross-serial dependencies (guaranteeing a substantive amount of expressivity) while still being parseable in PTIME (and hence also processable relatively efficiently). What these findings suggest is that the types of structures characterizing the logic of language in terms of the inferential laws that are valid classically potentially arose as the perfect fit between expressivity and (domain-general) processability, and

\(^{1}\)C&C seem to confuse categorial with categorical grammar. See [7] for further details.
hence were favoured from the evolutionary perspective developed by C&C. To recapitulate, we find that the thoughts-phonology correspondence, insofar as its structure may indeed be successfully characterized in terms of that of inferential processes, may itself be extracted from the general laws of classical inference, with the particularities entering into this process lending themselves to a motivation in terms of the communicative function of language.

I shall turn now to a more detailed inspection of the general discussion making up the context for C&C’s claim regarding the communication-specific nature of the thoughts-phonology mapping. Their argument targeted a suggestion made by Chomsky (1) that language may initially have served the sole function of being a carrier for thought, with its communicative role having developed only at a later stage. In particular, C&C claimed that such a view would not allow for an explanation of any kind of principles of UG governing the thought-phonology mapping: if the latter is indeed specific to communication, as C&C have it, then the UG principles involved in its specification apparently cannot find their motivation in the initial function of language as a carrier for thought. To what extent does this argument remain valid in light of claim made above that the thought-phonology correspondence actually is shaped to a considerable extent by the structure of inferences, themselves an important component of thought? Note first that the source of Chomsky’s suggestion cited by C&C is of Minimalist origin, a tradition taking at most Merge (or, more generally, recursion) to be language specific (2). Hence, we may reduce the question to one concerning this particular operation: to what extent is it independently motivated by the structure of thought? Resolution is found by appeal to Vermaat’s work (10), who argues the traditions of Minimalism and CTL to have much in common. In particular, Merge is seen here from a perspective of Natural Deduction as akin to the role of use for logical implication (or Modus Ponens), complemented by a rule of proof meant to capture discontinuous dependencies. Thus, it seems possible to, at least in large part, provide a motivation for the particular syntactic operation under discussion by appeal to the structure of thought processes involved in inferential acts, with another part having to be motivated by appeal to considerations of human processability in order to obtain the proper restriction of the classical inferential law involved. Note, however, that if Merge is so viewed as a restricted instantiation of Modus Ponens, it can actually no longer be seen as being specific to natural language, in that it was inherited from the inferential patterns governing thought, in turn taken to be independent of linguistic communication by (ii) above (which begs the question as to how the capability of performing inferences evolve).

In conclusion, I have argued against C&C’s claim that any kind of thought-phonology mapping made available by language must be communication specific, arguing instead from a perspective of CTL that its structure depends largely upon that of logical inference. Communication was thereby assigned a more modest role, essentially entering into the obtainment of the proper restriction of the classical laws of inference that would still allow a considerable amount of expressivity while at the same time guaranteeing PTIME parseability. Crucially, this approach seems consistent with C&C’s more general claims (thus preventing it from serving as a counterargument to their overall program), in that no amount of innate language-specific structure had to be postulated.

I concluded by evaluating the consequences for C&C’s stance against the possibility of motivating Minimalist UG Principles from the perspective on language suggested by Chomsky. In particular, I claimed this argument to no longer hold, stating instead, by reference to Vermaat’s work, that Merge, considered in Minimalism as the only candidate to qualify as language-specific, reflects in very large part the structure of inferential processes involving Modus Ponens.

(Number of words: 1982)

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