Phase-based models of grammar hold that the role of syntax is to build formal objects that are interpretable at the interface between semantics and syntax. Derivations are believed to be cyclic, such that a structure is built until it constitutes a category of the right type, which can then can be mapped into one of the two basic semantic primitives: referential expressions or propositions. At such point in the syntactic derivation, a cycle or phase is complete, and the syntactic object is ‘shipped off’ to the semantic interface. In the syntax, only certain components of it remain accessible for further syntactic manipulations.

According to Arsejinovic & Hinzen (2011), the syntactic consequence of this model is that recursion – the basis of the generative capacity of language – does not occur within a single phase. The semantic consequence is that at each point in a derivation of a complex structure, only a single element is interpretable, so that the extension or semantic value can be calculated. Such cyclic accounts of referential opacity predict asymmetries in the interpretation of matrix and embedded constituents, but are silent on whether embedding itself introduces complexity. The overarching goal of this paper is to examine how structural complexity arising from embedding can be represented in this model, and whether grammatical complexity should be defined in terms of compositional semantics, or phrase structure. More specifically, we shed light on the complexity that recursion introduces in grammar and meaning by comparing child and adult patterns of production of recursive noun phrases.

The results of this study provide evidence for the limitations of syntax-only or semantics-only approaches to complexity in certain kinds of complex NPs – despite the fact that these NPs are made up of the same syntactic and semantic ingredients.

Modification introduces complexity in the syntax and the semantics of noun phrases. Its use in natural language is regulated by the Maxim of Quantity: just enough information to identify a referent, but no more than is needed. Adult speakers make choices about the amount of descriptive content employed when labeling a referent, and these choices are intricately conditioned by discourse (Heller & Chambers 2014). The acquisition literature contains two contrasting pieces of evidence in regards to the referential behavior of children. On one hand, five-year olds are fully sensitive to context in their production of modified NPs, using adjectives (the small glass) only when a competing referent was present in the context (i.e., a large glass), and only when relevant from the perspective of their conversation partner (Nadig & Sedivy 2002). On the other hand, there seems to be a productivity gap, as most of the nouns produced by children are simple DPs with no modification. PP modification, in particular, appears heavily constrained in the speech of children. Do children’s limitations find their roots in the syntactic or the semantic complexity of NP modification? We present evidence from an elicited production study of doubly-modified definite descriptions that differ minimally with respect to the locus of application of the second modifier. In simple modification, the same (highest) referring NP can be doubly modified by two independent restrictive PPs.

1. The plate [under the table] [with oranges]

In recursive modification, the second modifier restricts the referent contained in the first PP modifiers.

2. The bird [on the alligator [in the water]]

On the surface, these complex DPs are ambiguous as to the structural attachment of the second PP. Set up in such specific contexts these two nominal expressions differ minimally as to the depth of embedding of the second prepositional modifier. In (1) the head noun is modified by two independent prepositional phrases (PPs). In (2), the head noun is restricted by a PP modifier, which is in turn modified by a second PP. We refer to the latter case as recursively modified descriptions. This difference is revealed in the truth conditions for (1) and (2), given in (3a) and (3b), respectively:

3a. *Truth conditions for the Non-recursive DP:* The unique $x$ such that $x$ is a plate and $x$ is under the unique $y$ such that $y$ is a table and $x$ is with the unique $z$ such that $z$ are oranges [got broken]
b. **Truth conditions for the Recursive DP:** The unique $x$ such that $x$ is a bird and $x$ is on the tree is water [got the worm].

The compositional operations that derive the truth conditions in (3) are made up of the same core, syntactic and semantic ingredients. Therefore, given standard assumptions about the syntax and semantics of nominal expressions and PP modification there should not be, in principle, differences in children’s production patterns, since all the elements and operations present in non-recursive modification are also present in recursive modification. These two NP types can be used to examine the development of complexity in the noun phrase, separating quantity of descriptive context vs. level of embedding.

Complex NPs such as the ones we examined provide evidence for the limitations of syntax-only or semantics-only approaches to complexity. Structurally, these complex DPs involve identical parts, containing the same types (and numbers) of lexical-level categories, and the same types (and number) of maximal projections. The same adjunction mechanism is involved in the integrating of the parts as well. The components that enter the syntactic computation do not help us articulate the observed difference in complexity. However, both the order of acquisition and the overall asymmetries in productivity patterns indicate that children and adults find the structure in (2) more difficult than the structure in (1). As such, the semantic operations involved in the interpretation of (1) and (2) do not reveal the differences they have in semantic complexity, which are revealed in the truth conditions given in (3). Standard assumptions about how phrases are generated by the syntax, and about how they are interpreted in a compositional semantic system, does not lead to a characterization of this difference. But we know that the descriptive conditions associated with the recursive case are more complex. At the point in a referential task in which speakers have to uniquely describe the target, the recursive condition requires the representation of an intermediate domain (level 1) within which the middle iota operator (which binds the alligator variable in the cases considered) must binds the first variable of the lowest relational predicate (i.e. the preposition).

At a higher layer in a recursive structure the variables in the lowest PP are already saturated. As a consequence, applying these operations recursively/cyclically isolates independent scopal domains. The order in which operations apply (modification, in semantic terms, or in syntactic terms, embedding), results in more complex, restrictive representation. The case that we examine involving a second level of embedding, fall into a lacuna in A&H’s discussion. Since A&H only distinguish between the two potential meanings of a structure (the referential and the predicative), there is no way of expressing the difference between recursive and non-recursive modification since at that point, both PP modifiers have already become predicates. The specific challenge represented by recursively modified DPs shows that each step in recursion introduces an independent layer of complexity. This is not predicted by a theory of phases in which phases that are embedded lower than the current merge point are rendered inert to syntactic computation. Our data suggests that elements contained in lower phases remain visible at LF, but their scope possibilities are restricted by the derivational history.

We review an emergent literature that suggest that children’s difficulties with modification in general, and specifically with recursion. Second, we consider the basic semantics and syntax of modification, as well as a recent proposal about the interactions between hierarchical relations and semantic relations between phases. We then present a study comparing children’s and adults’ production of recursive and non-recursive modification, and find there is an asymmetry between the two. This finding suggests that recursive embedding specifically introduces complexity that goes beyond the elements and operations used during the semantic composition of the structure, or the cyclic syntax that generates it. Last, we discuss the consequences for our understanding of the interaction between structural embedding and complexity in interpretation.

