

The Recursive Set-Subset Ordering Restriction Overrides Adjective Ordering Restrictions: Evidence from Romanian 4-Year-Olds and Adults

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1. Introduction

Long-standing research on adjectives argues that languages order adjectives according to a hierarchy of dimensions, also known as Adjective Ordering Restrictions (AORs). As argued by Scontras et al. (2017), for instance, speakers of a variety of languages (English, Hungarian, Mandarin Chinese, Dutch, a.o.) prefer to place Color adjectives closer to the noun than Size adjectives:

- (1) a. long green leaves
b. ?? green long leaves

It is unclear whether these ordering preferences are syntactic, semantic or cognitive (a matter of subjectivity). However, it remains an empirical fact that speakers of many languages exhibit preferences with respect to how they order adjectives, although there may be more flexibility in languages such as Greek (Leivada & Westergaard 2019), Hebrew (Trainin & Shetreet 2021) or Romanian (Cornilescu & Nicolae 2016, Cornilescu & Cosma 2019). Interestingly, though, children show more variability than adults in their ordering of adjectives (Lee et al. 2018), which is unexpected if AORs are considered syntactic UG constraints.

A relatively unexplored phenomenon is adults' and children's sensitivity to pragmatic contexts which require identifying subsets among sets, and how this relates to AORs. Generally, speakers are argued to exhibit the tendency to place Color adjectives closer to the noun than Size adjectives. Here, we argue instead that the use of adjective order to refer to subsets among sets is stronger than universal crosslinguistic adjectival preferences. We show that, in a pragmatic context where the speaker and his interlocutor talk about a set of *long leaves*, and the speaker wants to refer to the *green long leaves* out of a set of *long leaves* rather

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than to the *yellow long leaves* or the *orange long leaves*, speakers prefer the order *the green long leaves* over the order *the long green leaves*.

In the current paper, we address this question from an experimental standpoint, investigating the role played by set-subset contexts in adjective ordering preferences in the case of Romanian 4-year-olds and adults. Previewing the results, we show that, in Romanian, orderings of adjectives which involve hierarchical structure and entail the recursive set-subset relation reflect the primary compositional mechanism of language.

2. Adjective Ordering Restrictions (AORs)

2.1. AORs and the challenges they pose

The literature on adjective orderings generally assumes that adjectives are ordered in English (and other languages) depending on the dimension they specify. Various AORs have been proposed: some account for the order by resorting to a more fine-grained classification of dimensions (2a, b, c), while others argue that the ordering of more specific dimensions is driven by general properties, such as subjectivity, for instance (2d).

- (2) a. Value > Dimension > Physical Property > Speed > Human propensity > Age > Color (Dixon 1982)
 b. Quality > Size > Shape > Color > Provenance (Sproat & Shih 1991)
 c. Subjective Comment > Size > Length > Height > Speed > Width > Weight > Temperature > Age > Shape > Color > Origin > Material (Scott 2002)
 d. Subjective > Non-subjective (Scontras et al. 2017)

A consensus has not yet been reached with respect to whether these orders are fixed syntactically, semantically, or cognitively. According to the syntactic account of Cinque (1994, 2005, 2010), there are separate functional projections for each type of adjective in the structural representation of adjective modification. According to the cartographic theory, English orders adjectives by observing a fixed syntactic hierarchy, while Romance languages show a mirror order of English, deriving the inverse order from the basic (English) one through a complex succession of movement operations (*Roll-Up*)-which we will further detail in the next subsection.

However, not all studies agree on whether the order of adjectives is fixed. In fact, Cornilescu & Giurgea (2013), Cornilescu & Nicolae (2016), and Cornilescu & Cosma (2019) argue that, in Romanian, a Romance language, adjectives may be more freely ordered than in English. A similar claim has been made for Greek (Leivada & Westergaard 2019) and Hebrew (Trainin & Shetreet 2021).

Various arguments have been brought against the (purely) syntactic account of AORs and in favor of a more cognitive or semantic account. One argument comes from the absence of a clear consensus about which segments of the adjective hierarchy are (more) fixed and which are not. Some ordering preferences in the hierarchy may be stronger than others. For instance, the ordering of Shape

and Color adjectives is at chance level in a google search done by Truswell (2004), as well as in the corpus and experimental work of Scontras et al. (2017). While adults consistently place Size adjectives closer to the noun than Shape adjectives, they vary in their ordering of Shape and Color adjectives (Grohe & Shulz 2021). Such findings shed doubt on the idea that AORs are (purely) syntactic in nature. According to Scontras et al. (2017), AORs are guided by subjectivity considerations: less subjective adjectives are placed closer to the noun than more subjective ones.

Another argument in favor of a more cognitive account is that, as shown by Rosales Jr. & Scontras (2019), AORs in English persist even in the presence of the conjunction *and* (*long and green leaves*). If AORs hold regardless of the structure involved, then it is more likely that they are not syntactic in nature, but cognitive. However, in Spanish, adjective orders are more flexible in the presence of conjunction, which suggests that adjective stacking in the absence of conjunction might involve structural hierarchy in a way coordination does not. Given challenges faced by both syntactic and semantic/cognitive accounts, the debate about the content and nature of AORs is quite alive in the linguistic field. Interestingly, Scontras et al. (2019) try to settle this debate by arguing for a unified grammatical-cognitive account, proposing that pressures from successful reference resolution in the hierarchical nominal domain constrain less subjective adjectives to merge earlier with the noun than more subjective ones.

AORs also pose challenges for language acquisition. For instance, it has been observed that English 2- and 3-year-old children do not yet have stable adjective ordering preferences (Lee et al. 2018). Similarly, even for clear cases such as Size and Shape, German preschool children place Shape adjectives closer to the noun than Size adjectives to a lesser extent (69%) than adults (96%).

Thus, drawing generalizations about AORs is problematic both across languages and for the same language, in adult, as well as child language. Importantly, neither the issue of whether orders are fixed, nor the nature of these orders has been investigated by looking at the recursive set-subset relation.

2.2. AORs in Romanian

In the current research, we focus on the case of Romanian, a Romance language which differs from English in several respects (agreement, pre-/postnominal positioning of the adjective, order of adjectives).

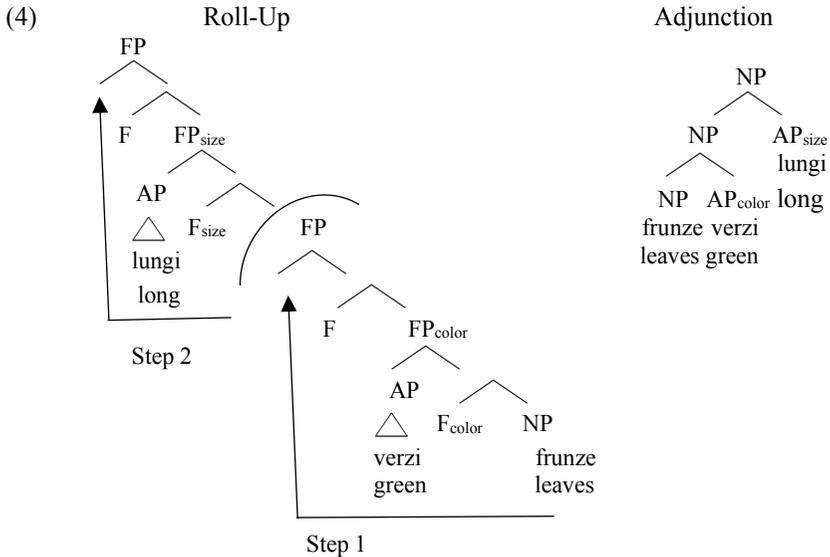
Unlike in English, where there are no nominal agreement markers on the adjectives, in Romanian, a language endowed with rich morphology, adjectives agree with nouns in number and gender (see 3). This may create an additional challenge for the acquisition of adjectives in Romanian in comparison to English, a language with poorer morphology. Romanian children have to add the appropriate number and gender marking on the adjectives modifying the nouns.

Another difference between Romanian and English is that adjectives are (mostly) postnominal in Romanian, while they are prenominal in English:

- (3) a. (the) long green leaves (En)
 b. *frunze (le) verzi lungi* (Rom)
 leaves.F.PL(-the.F.PL.) green.F.PL. long.F.PL
 ‘the long green leaves’

The postnominal order has been accounted for by resorting to N-to-D movement in Romance (Cinque 1994, 2005, 2010) but no movement in English.

In addition, the ordering of adjectives in Romanian seems to differ from the ordering of adjectives in English. According to Cinque (1994, 2005, 2010), adjectives in Romance (Romanian included) are a mirror order of adjectives in English (see 3a, b). In order to capture the mirror effect, Cinque (1994, 2005, 2010) proposes a Roll-Up-of-N account, where the mirror ordering is derived via a set of movement operations starting from the basic English order of adjectives. For example, in (4), the NP moves out of its position to an outer specifier (Step 1) of FP_{color} , then the newly formed FP containing FP_{color} moves out of its position to the outer specifier of the projection hosting FP_{size} (Step 2).



While Cinque’s analysis (1994, 2005, 2010) captures the mirror effect of Romance, the cartographic approach is not the only possible account. An alternative account is the Adjunction-of-Adj view (Kremers 2003, Abels & Neeleman 2010), according to which languages differ in terms of branching directionality. Thus, English adjoins adjectives to the left, while Romanian adjoins adjectives to the right (see 3, 4). Assuming that adjunction observes AORs in both Romanian and English, we obtain a mirror effect of English in Romanian.

The idea that Romanian orders adjectives inversely to English has been under debate, however. Based on a corpus of contemporary Romanian language, Cornilescu & Cosma (2019) argue for a more flexible ordering of adjectives in

Romanian than in English. While evaluative adjectives always tend to appear further away from the noun, more objective adjectives compete over the same positions, showing a more variable ordering. These findings are also confirmed experimentally by Luciu & Bleotu (to appear) and Trușcă & Bleotu (to appear).

Luciu & Bleotu (to appear) investigate the Size>Age>Shape>Color adjective ordering in British English and Romanian by means of a forced choice task where participants had to choose between sentences with adjectival orders in accordance with AOR and sentences with mirror adjectival orders (see 5). British English speakers' choices support the idea of a fixed hierarchical ordering in English, while Romanian speakers' choices revolve around 50%, indicating that both forms are acceptable.

- | | |
|----------------------------------------------------------------|------------------------------------------------------------------------------------------------|
| (5) a. Size-Color (English)
<i>I have a tiny red house.</i> | a'. Mirror Size-Color (Romanian)
<i>Eu am o casă roșie mică.</i>
I have a house red tiny |
| b. Color-Size (English)
<i>I have a red tiny house.</i> | b'. Mirror Color-Size (Romanian)
<i>Eu am o casă mică roșie.</i>
I have a house tiny red |

Trușcă & Bleotu (to appear) tested native British English and Romanian speakers using a Likert acceptability task, where participants had to rate sentences containing a noun and a sequence of two adjectives belonging to two dimensions (Quality/Size/Color) on a Likert scale from 1 (fully unacceptable) to 5 (fully acceptable) (such as the ones in (5)). The results show that British English speakers rate adjective sequences in accordance with AOR around point 4 and adjective sequences going against AOR around point 2. In contrast, Romanian speakers rate both adjective sequences in accordance with AOR and adjective sequences going against AOR similarly, i.e., around 3. These ratings support the idea that the ordering of Quality>Size>Color adjectives is fixed in English, but freer in Romanian. Interestingly, even Quality adjectives (the most subjective in the hierarchy) are often accepted in a position closer to the noun than Size or Color adjectives in Romanian, a finding which challenges the proposal that subjectivity determines the order of adjectives (Scontras et al. 2017). Instead, the flexible order of adjectives could easily be captured by adjunction (Abels & Neelman 2010).

In conclusion, Romanian shows a more flexible order than English, which makes Adjunction a more suitable representation for adjectives in Romanian.

3. Recursive adjectives and the Recursive Set-Subset Ordering Principle

A great amount of work on adjectives has focused on AORs outside (pragmatic) context. In the default situation, two successive adjectives are often interpreted as connected through Coordination, i.e., Direct Recursion (Roeper 2011, Hollebrandse & Roeper 2014): *long green leaves* is understood as 'long and green leaves', and *green long leaves* is understood as 'green and long leaves' (see 6). On a symmetric coordinative reading, *long green leaves* and *green long leaves*

have the same reference. Given the referential identity between these two expressions, the preference for certain adjective orders must arise from an additional (semantic/syntactic/pragmatic/cognitive) constraint operating on default coordinative semantic relations among adjectives.

(6) Size-Color (English)
long green leaves

b. Color-Size (English)
green long leaves

a1) Coordinative Interpretation:
long and green leaves

b1) Coordinative Interpretation:
green and long leaves

a2) Recursive Interpretation:
[long [green leaves]]

b2) Recursive Interpretation:
[green [long leaves]]

However, coordination is not the only interpretation successive adjectives may receive. In a context where there are several leaves (a group of green leaves-both long and short, and a class of long leaves-both green and orange), *long green leaves* picks out the subset of long leaves from the set of green leaves, while *green long leaves* picks out the subset of green leaves from the set of long leaves. Importantly, under an Indirect Recursion reading (Roeper 2011, Hollebrandse & Roeper 2014), which we will refer to as *the recursive interpretation*, adjective orderings observe the *Recursive Set-Subset Ordering Constraint (RSSO)* (7). This leads to the *Set-Subset Hypothesis* in (8), predicting that language should be more sensitive to RSSO than the cognitive dimensions of adjectives. For instance, when the set is specified by a Size adjective and the subset is specified by a Color adjective, the Size adjective will still appear closer to the noun than the Color adjective, even though observing AOR would lead to the inverse ordering.

(7) *The Recursive Set-Subset Ordering Constraint (RSSO)*

In a context requiring identifying a subset within a set, the adjective specifying the set is merged to the noun earlier than the adjective specifying the subset.

(8) *Set-Subset Hypothesis*

If RSSO functions as a fundamental principle of UG, then compositional interpretation of hierarchical structure must overrule cognitive AOR preferences.

Recursive adjectives pose interesting challenges for acquisition. The developmental path favors coordination as a first stage of interpreting recursive constructions. Multiple experiments have been conducted for a variety of categories: verbal compounds (Hiraga 2009), possessives (Gentile 2003, Limbach & Adone 2010, Pérez-Leroux et al. 2012, Roeper et al. 2012, a.o.), prepositional phrases (Sevcenco et al. 2017, Sevcenco & Avram 2018, Bleotu 2021), adjectives (Matthei 1982, Bryant 2006, Gu 2008), and sentential complements (Hollebrandse et al. 2008, Hollebrandse & Roeper 2014). Not only do children handle coordination easier than recursion, but they tend to reduce Indirect

Recursion (Same Category Embedding) to Direct Recursion (Coordination), interpreting recursive structures as coordinative (i.e., *the parrot next to the hamster next to the bunny* is often understood as *the parrot next to the hamster and next to the bunny*).

Interestingly, adjective recursion is no exception to children's tendency to reduce recursion to coordination. Corpus studies (Gu 2008) show that children's first uses of multiple adjectives are coordinative ([Adam 2.3]: *I funny little boy*). Moreover, experimental studies confirm this tendency: 3- and 4-year-olds often understand adjective sequences coordinately rather than recursively (e.g., *the second green ball* = 'the second and the green ball' rather than 'the second of the green balls' - see Matthei 1982, *big black balls* = 'big and black balls' - see Bryant 2006). In addition, in an experiment testing recursive structures with adjectives belonging to the same Size dimension, as well as recursive possessives, Foucault et al. (2022) found that English children younger than 6 had difficulties with structures involving two Size adjectives like *big big mushrooms* (rate of recursive readings around 20%), but they fared better with recursive structures involving three adjectives like *small big small mushrooms* (rate of recursive readings around 50%). In contrast, children handled adjective coordination in a more adult-like manner than recursion. They also fared better with recursive possessives, which suggests that adjective recursion is more complex than other types of recursion, possibly due to the semantic complexity of the set-subset relation and the challenges of gradable adjectives. Bleotu & Roeper (2021a, b) also found that Romanian 5-year-olds handle coordination between gradable adjectives specifying the same dimension (Size) better than recursion, and, unlike adults, they interpret recursive gradable adjectives as coordinated. Although indirect PP-recursion is available to 5-year-olds (Bleotu 2021), adjectival recursion seems not to be (accuracy rates of 35% for recursive structures with two adjectives and 45% for recursive structures with three adjectives). These findings are explained by Bleotu & Roeper (2021a, b) in terms of syntactic complexity (the Roll-Up operation for Romanian) and semantic complexity (establishing the set-subset relation), along the lines of Weicker (2009). While recent experimental work suggests that both English and Romanian children find adjectival recursion challenging, it is not clear whether the difficulty stems from a failure to order Set-Subset adjectives in accordance with RSSO or the additional challenge posed by recursion involving gradable adjectives specifying the same dimension (Size). Children's difficulty with *small big mushrooms* might have more to do with the difficulty of evaluating Size relative to different domains (e.g. *small* with respect to *big mushrooms*) rather than with identifying subsets within sets. In order to tease apart these two separate challenges, it is thus important to investigate sequences of adjectives involving adjectives specifying different cognitive dimensions (such as Color, Shape, Size, a.o.) and see whether children's problem with identifying subsets within sets persists for such sequences.

4. Experiment on the Recursive Set-Subset Ordering Principle in Romanian

While recent experimental work on RSSO (Bleotu & Roeper 2021a, b, Foucault et al. 2022) looked at sequences of two gradable Size adjectives, the current experiment investigates the ordering of sets and subsets by looking at sequences of two Size-Color adjectives in Romanian.

4.1. Aim

The experiment sets out to test whether Romanian children and adults observe the RSSO for adjectives expressing Size and Color even when in conflict with the AOR, i.e., even in a context where the set is defined by Size adjectives and the subset by Color adjectives, and the general AOR would lead to the inverse order. Investigating a context where RSSO and AOR are in conflict can help determine which principle plays a more fundamental role in ordering adjectives.

4.2. Participants

The participants were a group of 17 Romanian monolingual TD children (Age range: 3;2-5, Mean age: 4;35, M=8, F=9) and a control group of 17 adults.

4.3. Predictions

If AOR is stronger than contextual considerations, then we expect participants to always choose the order $N A_{Color} A_{Size}$, regardless of whether the context requires an adjectival ordering opposite to AOR ($N A_{Size} A_{Color}$). If, on the other hand, RSSO is primary, then AOR cannot be respected in case of conflict.

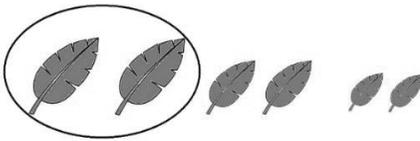
4.4. Materials and Procedure

Participants were administered a forced choice preferential naming task. They were randomly presented with 8 picture sets, 2 picture sets for flowers, leaves, giraffes, squirrels. The picture sets involved a) three groups having the same color, but a different size, and b) three groups having the same size, but a different color. Each picture set contained one circled group. Children saw one picture set at a time, and they had to choose from two options how they would name the circled group (Table 1, Figures 1, 2). The options involved nouns and Color and Size adjectives occurring in two different orders.

Table 1: List of experimental items

Items	N SizeA ColorA	N ColorA SizeA
<i>frunze</i> leaves	<i>frunze lungi verzi</i> leaves long green	<i>frunze verzi lungi</i> leaves green long
<i>flori</i> flowers	<i>flori mici roșii</i> flowers small red'	<i>flori roșii mici</i> flowers red small
<i>veverițe</i> squirrels	<i>veverițe slabe portocalii</i> squirrels thin orange	<i>veverite portocalii slabe</i> squirrels orange thin
<i>girafe</i> giraffes	<i>giraffe înalte maronii</i> giraffes tall brown	<i>girafe maronii înalte</i> giraffes brown tall

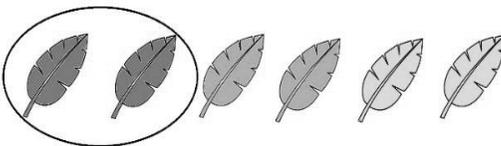
For situations where the RSSO is in harmony with AOR, participants saw the picture in Figure 1 and heard the text in (9), rendered in a neutral tone. The text has been translated from Romanian into English for convenience, except for the critical choices, which are presented in Romanian.

**Figure 1: Example item for RSSO in harmony with AOR**

(9) “Let’s look at these leaves! They are all green. Some are long, some are medium size, and some are short. The circled leaves are:

frunze verzi lungi OR *frunze lungi verzi*
leaves green long leaves long green
‘long green leaves’ ‘green long leaves’?”

For situations where the RSSO is in conflict with AOR, participants saw the picture in Figure 2 and heard the text in (10), rendered in a neutral tone.

**Figure 2: Example item for RSSO in conflict with AOR**

(10) “Let’s look at these leaves! They are all long. Some are green, some are orange, and some are yellow. The circled leaves are:

frunze verzi lungi OR *frunze lungi verzi*
leaves long green leaves long green
‘long green leaves’ ‘green long leaves’?”

4.5. Results

Children behaved similarly to adults (see Figure 3), showing sensitivity to properties identifying the set-subset hierarchy. In terms of individual responses, 15 children out of 17 and 13 adults out of 17 were consistent with the RSSO. Regardless of whether the adjectives named Color or Size, participants chose to place Set adjectives closer to the noun than Subset ones. For instance, in a context where they identify green leaves out of a set of long leaves of various colors, children and adults preferred to name them *frunze lungi verzi* ‘green long leaves’, even if the natural order would be *frunze verzi lungi* ‘long green leaves’.

Using R (2021), we fitted a mixed effects model with Order (Size-Color, Color-Size) as a dependent variable, Group (children/ adults), Conflict (Conflict between RSSO and AOR, No Conflict between RSSO and AOR), the interaction between Group and Conflict as fixed effects, and random slopes per items (flowers/leaves/ squirrels/giraffes) and participants. If children pattern like adults, we should (crucially) see a significant effect of Conflict, since the choice of word order in both 4-year-olds and adults will change when there is a conflict present. The results confirm this prediction, revealing a significant effect per Conflict ($\beta = -4.6745$, $SE = 1.504$, $Z = -3.108$, $p = 0.0018 < 0.05$), but no significant effect per Group ($p > 0.05$), or the interaction between Group and Conflict ($p > 0.05$).

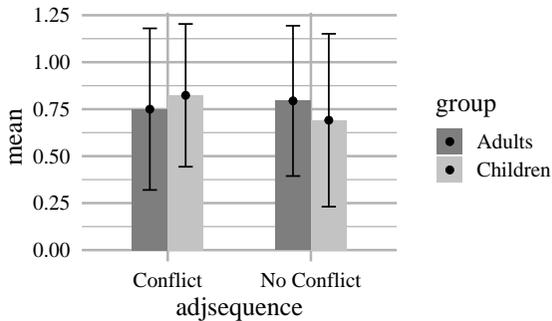


Figure 3: Accuracy in contexts of (no) conflict between RSSO and AOR

5. Discussion

We find that Romanian children and adults are more sensitive to whether an adjective helps pick a set/subset rather than to what the adjective denotes (Color, Size). We propose that this finding can be explained if we assume that RSSO is a more fundamental principle for adjective ordering than AOR, which can be taken to operate on a cognitive level. More specifically, we argue that RSSO is a minimal interface principle which reflects the core structure-building capacity of Merge, taking priority over AORs. The Merge operation not only adds structure, but also fixes semantic scope through automatic compositionality. For instance, in order to derive a structure such as *green long leaves*, Merge will successively apply, adding adjectives to the noun (see 11). At a first step (Merge 1), Set

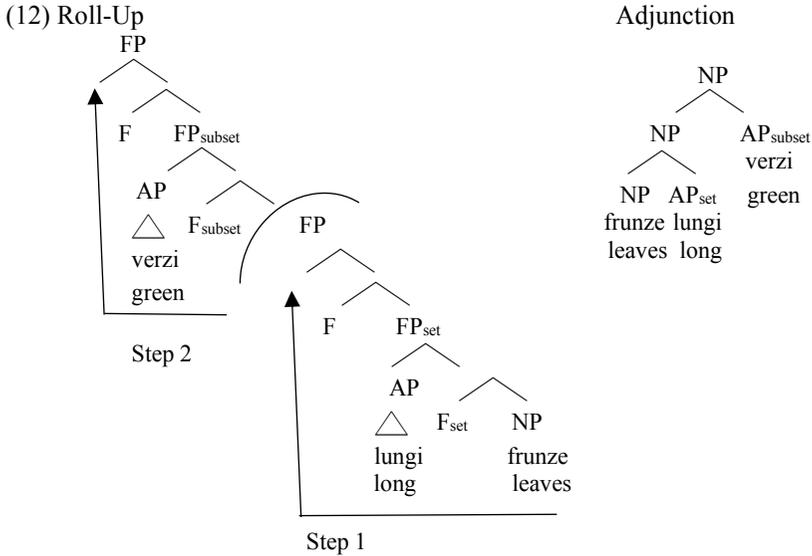
adjectives merges with the noun, forming a new set-denoting object, where the Set adjective establishes the Common Ground/the presupposition. At a second step (Merge 2), the Subset adjective merges with the previous set-denoting object, forming a new subset-denoting object. Importantly, Merge operates on the syntax-semantics interface, such that every structure-building operation is also an operation where an adjective assigns a property to the previous object (a simple noun or a noun modified by an adjective).

(11) Merge1: [*long leaves*]

Merge2: [*green [long leaves]*]

Several derivational options may be assumed for the corresponding Romanian adjectives, which occur in the mirror order. However, since we used a neutral tone for N + A sequences in our experiment, we leave aside analyses in terms of FOCUS and possible movement to the left periphery (Rizzi 1997, Teodorescu 2006), although we are aware that this is an interesting, fruitful area for further investigation. We thus focus on two main accounts. On the one hand, a possible syntactic implementation is Cinque's Roll-Up Theory (1994, 2005, 2010), according to which Set and Subset adjectives are always adjoined to the left of the noun in the basic order (corresponding to English), and the mirror adjectival order in Romanian is derived from the basic English one through successive movements. In (12), for instance, the NP moves out of its position to an outer specifier of FP_{set} (Step 1), the newly formed FP containing FP_{set} moves out of its position to the outer specifier of the projection hosting FP_{subset} (Step 2).

Another possible derivation of set-subset adjectival orderings in Romanian involves an Adjunction-of-Adj view (Kremers 2003, Abels & Neeleman 2010). In this account, the difference between English and Romanian lies in branching directionality: English merges adjectives on the left, while Romanian merges them on the right. What holds for both languages is that the Set adjectives are merged before the Subset ones, in accordance with RSSO. Given that both accounts can derive the mirror set-subset order in Romanian, we believe the Adjunction account is preferable on grounds of simplicity, economy (fewer movement operations) and intuitive mapping onto semantics. Language acquisition can decide between the two accounts. Unlike Roll-Up, which predicts more difficulty with RSSO for Romanian children than for English children, Adjunction predicts similar behavior — we leave this for future research.



6. Conclusion

In the current paper, we have shown that Romanian children and adults are more sensitive to whether adjectives refer to Sets/Subsets rather than to the cognitive dimensions like Color or Size. We propose that RSSO is a fundamental Merge principle for structure building and interpretation, guiding adjective ordering at the syntax-semantics interface. In contrast, AOR is not a minimal interface constraint, but a weaker cognitive constraint taking into account multiple cognitive dimensions. Importantly, minimal interface constraints are implemented in grammars before cognitive ones.

Further questions remain. One pending issue is whether English children perform differently with RSSO than Romanian children and why (not). AORs might be more easily overridden by contextual set-subset constraints in languages with more flexible AORs (such as Romanian) than in English. If so, this may shed light on the syntax underlying orderings of adjectives. Future experimental work in English and other languages will clarify this. In addition, another matter requiring further investigation is whether FOCUS might help establish/shift set-subset relations (i.e., *the green LONG leaves*).

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