Research in Generative Grammar
RGG 2022.01
Rivista di Grammatica Generativa
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Scalar implicatures like object A'-dependencies: feature inclusion in early grammars

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Abstract. It is a well-known acquisitional issue that preschool children avoid the derivation of scalar implicatures (SIs), i.e., they seem unable to process the implicit layer of meaning that is normally attached to scalar terms. Focusing on the scale of quantifiers <*some*, *all*> and based on previous grammar-based approaches, I argue for a syntactic, criterial interpretation of scalar implicatures, consisting in a feature-checking process of a [scalar] trait. When such derivation is paired with other operations connected to the scalar terms at issue, it may become problematic for preschool children: in the case of *some*, SI derivation is combined with Quantifier Raising, and I show that the structural and featural configuration of the constituents involved in the two operations leads to intervention effects (as predicted by Featural Relativized Minimality, Starke 2001; Rizzi 2004) via featural inclusion. In this spirit, a parallel between the acquisitional trajectory of SIs triggered by *some* and complex object A'-dependencies is put forth, where the non-enriched, plain interpretation of the scalar term in preschool years is understood as an attempt to modulate intervention.

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Cite as: Bressan, Veronica. 2022. Scalar implicatures like object A'-dependencies: feature inclusion in early grammars. *RGG*, 44(1). pp. 1–29. Lingbuzz Press.

1 Introduction

Scalar implicatures (SIs) are one instance of the broader phenomenon of quantity-based implicatures, and their function is to convey additional layers of meaning to the literal semantic import of an utterance in a systematic fashion. The covert mechanism underlying SIs is schematized below:

(1) a. *Some* students are Italian.
    b. Literal (logical) interpretation: *Some and maybe all* students are Italian.
    c. Scalar implicature: *Not all* students are Italian.
    d. Scalar interpretation: *Some but not all* students are Italian.

The meaning of (1a) has a plain interpretation spelled out in (1b); however, once the very natural enrichment in (1c) is factored in, the interpretation in (1d) becomes relevant: it consists in the negation of *all*, i.e., a salient alternative to *some*, which would originate a stronger interpretation than what is presumably intended by the original sentence. The relevance of alternative lexical items is captured by the notion of Horn scales, i.e., ordered sets of lexical items organized by informativity, as in <*some*, *all*>[1], where the most informative item (*all*) asymmetrically entails the weaker one (*some*) (Horn 1989).

Starting from the seminal work by Paul Grice (1975), SIs have been interpreted as a purely pragmatic phenomenon stemming from the conjunct application of the Cooperative Principle and the four Maxims of Quantity, Quality, Relation and Manner; however, this kind of characterization has become a matter of debate not only as a theoretical issue, but also with respect to the consequences that it has in accounting for the treatment of SIs in different populations of speakers, among which children acquiring their first language. Precisely, it has been observed that while preschoolers can count on good pragmatic skills, they struggle with the production and comprehension of SIs at least until their first years of school (Noveck 2001; Papafragou & Musolino 2003; Chierchia et al. 2004; Guasti et al. 2005; Pouscoulous et al. 2007; Katsos & Bishop 2011; Foppolo, Guasti & Chierchia 2012), until when they tend to accept the "logical" interpretation in (1b). This developmental pattern is, however,

1. The complete scale of positive quantifiers normally includes two more intermediate items, and it is spelled as <*some*, *many*, *most*, *all*>. For the sake of brevity, the reduced version <*some*, *all*> will be preferred throughout this work.

very heterogeneous, and a lot of variability has been observed with respect to the kind of Horn scale that was tested and the employed task, thus complicating a unified characterization of the acquisitional process of SIs.

In this work I depart from the Gricean account and elaborate on previous proposals in the literature that highlight the grammatical nature of SIs and their properties (Chierchia 2004; 2013; Chierchia, Fox & Spector 2011) with the aim of presenting a syntactic-driven approach to the phenomenon. This approach will then be used to investigate the reasons behind the late acquisition of SIs, focusing on the scale <*some*, *all*>. Some similarities in the acquisitional trajectories will lead me to explore the possibility that SIs and complex object A'-dependencies have a similar underlying complexity with respect to intervention effects as predicted by Featural Relativized Minimality (Starke 2001; Rizzi 1990; 2004).

This paper is organized as follows: section 2 illustrates two competing approaches to SIs and the numerous experimental studies on SI acquisition; section 3 describes a new development of the grammar-driven approach to SIs and its implementation with the scale <*some*, *all*>; section 4 presents the predictions of this model in the domain of acquisition, with a parallel between SIs and object A'-dependencies; section 5 discusses some possible implications and developments of the proposal; section 6 gathers some concluding remarks.

2 Theoretical background: scalar implicatures and their acquisition

In the original Gricean formulation, conversational implicatures – and thus SIs, as well – are coherently derived from the cooperativity framework, according to which any conversational exchange between collaborative speakers is ruled by the Cooperative Principle and the four Maxims (Grice 1975): by employing these communicative tools, the conversation may fruitfully progress until the shared conversational goal is reached. In this spirit, each participant in the speech act is required to be informative, i.e., to convey the largest amount of information that she has available (Maxim of Quantity), and not less. In this sense, the use of a quantifier like *some* in a cooperative exchange would automatically exclude the possibility that its stronger alternative *all* may also hold in the same context; hence, the derivation of a scalar implicature, where the stronger alternative is negated (cf. (1)).

Though this basic mechanism is generally accepted, at least at an intuitive level, the Gricean picture remains rather general with respect to the actual process of derivation of SIs, and it does not provide an adequate

description of all the properties of implicatures, thus leaving space to further refinements and alternative solutions. In particular, neo-Gricean formulations, which maintain the original strong pragmatic nucleus of SIs, have been opposed by a family of grammar-based approaches, which anchor SI calculation on syntactic-semantic processes[2]. These two alternative positions do not attempt to give an entirely pragmatic or grammatical explanation to the phenomenon, thus returning a simplistic characterization which does not fit the complex, interfacial nature of SIs (Marty & Chemla 2013; Chemla & Singh 2014; Fox 2014); rather the aim of the discussion is to unveil the extent to which the two domains are involved and intertwined in the computation, and to assess whether SIs can be described as a compositional or postcompositional linguistic phenomenon. With this premise in mind, a brief review of the two approaches will follow.

2.1 The neo-Gricean approach

The neo-Gricean family of approaches counts as the most natural development of the original theoretical framework proposed by Grice, holding that all implicatures are directly dependent on pragmatic competence and grounded on cooperativity considerations. Hence, their derivation is motivated by the import of new information that they bring to the conversation in order to get closer to the conversational goal of the interlocutors (Geurts 2010).

Starting from the idea of a cooperative exchange, the process of implicature calculation would be factored in at speech act level, after the preliminary semantic composition in which each lexical item is assigned with its plain meaning. In other words, after a relevant sentence S has been assigned with its literal interpretation [[S]], a set of alternatives ALT(S) to S is evoked[3], which also includes stronger versions of the relevant sentence, labelled S^+. At this point, a first inferential step is taken, also labelled 'primary implicature' (Sauerland 2004): following the Maxims and the Cooperative Principle, the mere fact that the speaker chose to utter S and avoided its stronger alternatives S^+ implies that she believes

2. A third alternative is to interpret scalar implicatures within the theoretical framework of Relevance Theory (Sperber & Wilson 1986): SIs would result from a compromise between the cognitive effort required to generate the inference and the benefits that such inference may bring. This interpretation is, however, not specific of SIs, but is rather a more general approach that is applied by proponents of Relevance Theory across the board, to all kinds of linguistic derivations. Therefore, I align with Chemla & Singh (2014) and do not include it here between SI specific analyses.

3. ALT(S) results from the union of contextually relevant alternatives and scalar alternatives. Cf. Chemla & Singh (2014) and the literature cited therein for a richer characterization of the process.

the literal meaning of the utterance at issue, and does not believe any of its stronger alternatives. As a second step, a competence assumption with respect to the utterer of S must be formulated, such that it must be certified whether she is opinionated about the more informative S^+ ('the epistemic step', Sauerland 2004): whenever the speaker is judged competent, such that she knows of all stronger alternatives whether they are true or not, then it must follow that she considers the S^+ to be false, and the desired scalar implicature is obtained[4]. The whole process, which is usually called exhaustification (inspired by the analysis of exhaustive answers by Groenendijk & Stokhof 1984), is schematized in (2) below:

(2) a. *S*: He will meet Mary or John.
b. *ALT(S)* = {(He will meet Mary), (He will meet John), (He will meet Mary or John), (He will meet Mary and John)}
c. *Stronger alternative (S^+)*: He will meet Mary and John.
d. *Primary implicature*: It is not the case that the speaker believes (S).
e. *Competence assumption/epistemic step*: The speaker believes that not (S^+).

Given this framework, the interpretation of SIs is that of a postcompositional phenomenon: that is why the neo-Gricean approach is defined as a globalist approach, and as such it is challenged, because the postcompositional assumption excludes the possibility of embedded implicatures calculated during semantic composition. Local, embedded SIs, however, are widely attested: the sentences in (3) not only serve as an example for an SI embedded under the belief operator (the predicate *believes*), but they also demonstrate that computing the implicature at root level would imply the reading in (3c):

(3) a. Mary believes that some apple is rotten.
b. *Stronger alternative*: Mary believes that all apples are rotten.
c. *Root implicature*: It is not the case that Mary believes that all apples are rotten.
d. *Local implicature*: Mary believes that not all apples are rotten.

Crucially, (3c) does not include the enriched interpretation of *some* as *some but not all*: to put it differently, it does not give any information of what the subject believes to be true (3d), but it rather provides a more

4. In case no competence assumption is certified, it must be the case that the speaker does not know the truth values of the stronger alternatives: the result is an ignorance implicature.

general negation of the fact that a specific belief is not entertained by the subject.

Further weaknesses of the postcompositional approaches are related to the actual role of the Maxims and to the extent to which SIs can be understood as a tool to make the conversation advance. Precisely, it has been observed that SIs arise even under a forced cancellation of the Maxim of Quantity (Fox 2014), thus invalidating the idea of its centrality in the process of exhaustification and stressing the triggering force of scalar terms alone, regardless of the conversational context. Finally, the automaticity of exhaustification has also been held responsible for contextual blindness effects (Magri 2009), which confute the idea that SIs only contribute to the conversational goal: thus, even though some neo-Gricean approaches have abandoned the assumption of postcompositionality (Sauerland 2004; Van Rooij & Schulz 2004; Spector 2007), their dominantly pragmatic characterization of SIs is still a matter of debate, opposed by alternative grammar-based theories.

2.2 The grammatical approach

Taking the weaknesses of the Gricean approach as a starting point, proponents of grammar-based approaches have tried to anchor SIs in some systematic grammatical process, mostly driven by semantic operations.

The common assumption is that exhaustification is mediated by a silent operator, mostly called O, whose effect in the sentence is similar to that of the exclusive operator *only* as both elements evoke a set of alternative entities among which they exclusively select the relevant one. Differently from neo-Gricean proposals, this process unravels during semantic composition: precisely, when the parse of a sentence S reaches the operator O in its progression, a decision must be taken whether to integrate it in the sentence meaning or not. If the enriched interpretation is required, then the operator is applied to S, the alternatives in ALT(S) are evoked and exhaustification is carried out in an algorithm-like fashion. The resulting meaning is [[O(S)]], i.e., the inference that the speaker only believes the version of S she mentioned and not the others. If, on the other hand, the insertion of O is not supported by the context, then no enrichment comes about, and the interpretation of S is just [[S]][5].

5. The fact that the grammatical approach requires a disambiguation step, where a decision is taken about the inclusion of the operator O in the compositional process has been interpreted as a disadvantage with respect to the pragmatic-oriented approach, because it may correspond to the addition of computational complexity. Such disambiguation step, however, may be understood as the manifestation of the integration between pragmatic and grammatical components, where contextual data interacts with

The systematicity of SIs and their compositional characterization represent the two main advantages of grammar-based accounts. First of all, the role of context and the importance of the Maxims are recalibrated in favour of an automatic process, compatible with the observed contextual blindness effects triggered by SIs (Magri 2009) and the apparently dispensable nature of Quantity (Fox 2014). Furthermore, the local calculation of the process is coherent with the observed embeddability of SIs, and with the fact that they interact with the local linguistic environment they are in nested in. A typical example in this sense is the interaction between scalar inferences and negation and Downward Entailing (DE) contexts in general, whose effect is a reversal in the monotonicity of the sentence they are inserted in. Changes in monotonicity crucially imply an inversion effect in the entailment relations that hold between scalemates: as a consequence, the weak scalar terms that usually trigger SIs are expected to become the most informative ones in DE contexts, thus losing their implicature triggering force:

(4) a. It's false that Sue harassed *some* students.
b. It's false that Sue harassed *some though not all* the students.
c. #Sue harassed *all* the students. (Chierchia 2004)

The example above shows how the derivation of a *some*-implicature originates an inappropriate interpretation when the scalar term is dominated by a negative polarity item (*it's false that*), and this sort of interaction would not be expected in case SIs were a global, postcompositional phenomenon.

Among the grammar-based approaches, the formulation provided by Chierchia (2013) stands out for its strong syntactic orientation and the appeal to locality constraints that are traditionally used in the study of syntax. In his framework, Chierchia assumes that exhaustification is syntactically projected by the operator O, which responds to some requirements that resemble very closely the syntactic Criteria proposed by Rizzi (1997; 2013; 2017): first, the activation of O is triggered only when a scalar term is found in its c-command domain; second, the local relation that is established between the covert operator and the target scalar term consists in feature-checking, as in the traditional definition of Agree (Chomsky 2000). According to this analysis, scalar terms are characterized by the featural bundle [σ, D], where the first trait represents scalar alternatives and the second stands for context-dependent alternatives; when O is characterized by the appropriate restriction (in Chierchia's terms: $O_{\sigma A}$), it will target strictly scalar alternatives, which will be as-

the semantic process.

signed with a '+' value, while contextual alternatives will play no role, hence the '-' value. Exhaustification will therefore look like (5):

(5) a. I will see Mary *or* Sue.
b. $O_{\sigma A}$ [I will see Mary $or_{[+\sigma, -D]}$ Sue]
c. *Scalar interpretation*: I will see Mary *or* Sue *but not both*.
(Chierchia 2013)

Interestingly, Chierchia's framework is able to capture the local and automatic nature of SIs by reusing syntactic notions and principles, without recurring to too many new pieces of machinery. In this sense, not only it provides a convincing account for SIs, but it also connects them to all other grammatical phenomena that are sensitive to minimality constraints[6] like object A'-dependencies, thus implicitly supporting the analysis I propose on the acquisitional side.

2.3 Scalar implicatures in child language

Regardless of the specific approach that is endorsed – either pragmatics-driven or grammar-driven – the general idea is that the necessary condition to obtain enriched scalar interpretations from scalar terms is to evoke the alternatives included in a given scale, compare their meanings and the entailment relations that hold among scale-mates and eventually choose the most fitting item for the context, while negating the unsuitable contenders. As a result of such process, SI-triggering lexical terms may either be assigned with their enriched interpretation, i.e., their upper-bounded meaning, or with their plain, lower-bounded meaning.

In the last twenty years, much experimental data on acquisition has shown that preschool children prefer to exploit the latter solution: for instance, their typical interpretation of the scalar quantifier *some* in a context supporting the implicature is not the enriched *some but not all*, but rather the plain *some and maybe all*. Interestingly, by choosing the lower-bounded interpretation they also choose the "safest" one, because it not only applies correctly in linguistic contexts where upper-bounded *some* is actually required and the stronger *all* would not be suitable; but it is also logically compatible with contexts in which the stronger item *all* could be supported, and in virtue of the entailment relation holding asymmetrically between the two items, using *some* results in an underinformative sentence, but not a wrong one.

6. See Chierchia (2004; 2013) for further parallels between SIs and Negative Polarity Items, i.e., another case of syntax-semantic phenomenon ruled by locality constraints.

Therefore, the lower-bounded alternative functions as some sort of *passe-partout*, with the only drawback of a deficit in informativity, but never ungrammaticality. This pattern has been confirmed across several scale types, but depending on the lexical category of each scale different ages of mastery have been observed, suggesting that this may represent a decisive factor to determine the acquisition. Following the classification by Foppolo & Guasti (2005), three groups of scales can be recognized based on the time window in which they start appearing:

- Discrete scales, i.e., scales of cardinal numbers (e.g., <*two*, *three*>) and degree modifiers (<*half*, *whole*>). SIs based on these scales are the first to appear in child grammars: around the fifth year of age children start rejecting statements in which these kinds of lexical items yield underinformative sentences (Papafragou & Musolino 2003)[7].

- Logical scales, i.e., scales of positive quantifiers (<*some*, *all*>, Noveck 2001; Papafragou & Musolino 2003; Guasti et al. 2005; Huang & Snedeker 2009; Katsos & Bishop 2011; Foppolo, Guasti & Chierchia 2012) and sentential connectives (<*or*, *and*>, Braine & Rumain 1981; Gualmini et al. 2001; Chierchia et al. 2004). It is generally accepted that children start to autonomously interpret the scalar items *or* and *some* with their upper-bounded meaning around their first years of school, i.e., at around six years, while before that age both items are interpreted inclusively.

- Epistemic scales, i.e., scales of modal verbs (<*might*, *must*>) and epistemic adverbs (<*perhaps, certainly*>). These Horn scales start triggering implicatures in a systematic fashion only around the eighth year of age, a couple of years later than the most common "logical" type (Noveck 2001; Doitchinov 2005).

This heterogeneous picture is further complicated by the difficulty in the elaboration of an effective experimental design for SIs, due to their ambiguous nature: not only they are strongly related to the context of derivation; but also, they constitute an additional layer of meaning to already well-formed – though infelicitous – utterances, so it is not obvious to put the experimental subject in the conditions to necessarily factor in such pragmatic enrichment. In this sense, experiments on SIs try to col-

7. The advantage of numerals with respect to other scalar terms seems to be confirmed at adult age, as shown by Marty, Chemla & Spector (2013)'s study of adult French speakers: they observed that while the derivation rate of *some*-SIs decreases under memory load, scalar implicatures with numerals do not show the penalization effect of the same memory load, and their derivation is even increased.

lect the subjects' evaluation with respect to the pragmatic felicity of the critical stimuli, rather than their truth conditions: this subtle difference is crucial for the success of the investigations, though it might not be immediate to grasp, especially for young subjects. That is why the choice of the task represents another major source of variability in the literature, which has resulted in contradictory observations: on the one hand, experimental methods that do not sufficiently stress the contrast between felicity and grammaticality have obtained very low rates of SIs even in older children (Noveck 2001), not doing justice to the sophisticated pragmatic skills that preschoolers can already count on and regularly exploit during their linguistic development (Baldwin 1993; Yatsushiro & Sauerland 2019). On the other hand, some action-oriented tasks (Pouscoulous et al. 2007) have been able to enhance – and to some extent even anticipate – child SIs, and a similar effect has been obtained by making the scalar alternatives salient in the context, dispensing children from autonomous retrieval (Foppolo, Guasti & Chierchia 2012). Nevertheless, it is not completely clear whether these facilitating experimental devices still test the specific competence to derive implicatures of the scalar kind, or rather some more context-dependent kind of inferences.

As a consequence of the heterogeneity of experimental data, different accounts have been proposed to describe the nucleus of complexity that prevents children from adult derivation of SIs. The pragmatic approach holds that in preschool years, before SIs are consistently derived, children lack some crucial pragmatic skill. Their scalar terms therefore come out more "logical" and their judgment of underinformative statements may be more tolerant (Pragmatic Tolerance, Katsos & Bishop 2011) with respect to adults' reasoning. This kind of approach, however, would not predict any variability with respect to the pattern of acquisition of SIs, contrary to the experimental results that have been reported above: if grasping contextual information or sensitivity to Gricean principles are crucial for SI derivation, then this should reasonably hold for all scales, regardless of their specific lexical type, so no graduality in the acquisitional trajectories is expected. Also, an immature pragmatic system should make non-scalar inferences based on contextual information, so-called ad hoc implicatures, equally unavailable, as their derivation arguably requires sensitivity to Gricean principles and informativity, as well. However, it has been shown that ad hoc implicatures are derived earlier and more easily than SIs (Stiller, Goodman & Frank 2015; Foppolo et al. 2021), suggesting that there must be some crucial difference in the two processes of derivation.

A different approach addresses the lack of SIs in early grammars in terms of failure to balance the processing costs required by exhaustification with the actual gains deriving from such operation, namely a higher

degree of informativity (Pouscoulous et al. 2007). Such processing-based account is generally endorsed by proponents of the Relevance Theory framework (Sperber & Wilson 1986), and according to this view children would just settle for a less relevant, non-enriched derivation instead of the more costly, exhaustive one. Again, this perspective would not predict differences in the treatment of different kinds of scales, nor between different kinds of implicatures, contrary to fact.

Finally, a lexical approach has been formulated, according to which the ability to derive SIs is dependent on the lexicalization of the relevant scales, and until this process is not completed, SIs are out of reach for early grammars. This means that even though children already know the lexical meaning of single scalar items, their systematic representation as Horn sets takes longer to be completed; hence, the inability to retrieve these lexical items as an ordered set in an automatic fashion. In this spirit, the early mastery of ad hoc implicatures would be explained by the fact that their calculation is not based on lexical sets but on contextual information, and a similar account would explain good child performance with respect to other non-lexical implicatures, including the free-choice interpretation of disjunctive statements (Singh et al. 2016; Tieu et al. 2016; Pagliarini et al. 2018; Foppolo et al. 2021).

Even though the aims of this work do not necessarily align with either of these approaches, it is interesting to observe that among these three formulations only the latter seems to capture the observed variability of child behaviour, thus highlighting the role of non-pragmatic skills in the derivation of scalar implicatures.

3 From exhaustification to the Scalar Criterion

In the following lines, I propose a possible development of the grammatical approach to scalar implicatures outlined by Chierchia (2013) in a more markedly syntactic direction, following the program of "syntacticization" of interpretive properties put forth by Rizzi (1997) with the criterial framework.

As a first premise, I assume the general process outlined in the previous section as the starting point of this analysis, namely the existence of a syntactically projected operation of exhaustification binding scalar terms to a covert operator O, and the first consideration concerns the characterization of such silent constituent. It has already been claimed that O is generally compared to its overt counterpart *only,* because the introduction of either of the two items in a sentence produces comparable exclusivity effects; what I argue is that such close characterization

may also be exploited to determine the position of the operator in the clausal spine, paving the way to the analysis of its possible interaction with other functional element. Considering that the operator must be able to establish some relevant relation with any scalar term, the possibility that O belongs to the DP system seems to be ruled out, because it would seem to leave out the possibility to apply exhaustification to verbal scales like <*might, must*>. A choice between the TP and the CP system is not so straightforward, instead, as both alternatives seem to be viable in principle. I tentatively take up the possibility that the operator may be located within the TP layer, following a broader discussion by Kayne (1998) with respect to the possible analysis of the overt adverb *only*. In his system, *only* belongs to the low periphery of the clause, and it is dominated by another similar head, which is described as its "phonetically unrealized counterpart": in the spirit of this analysis, I argue that the operator dedicated to exhaustification also belongs to the TP layer, and it can be described as the functional head Exh of an Exhaustifier Phrase (ExhP)[8].

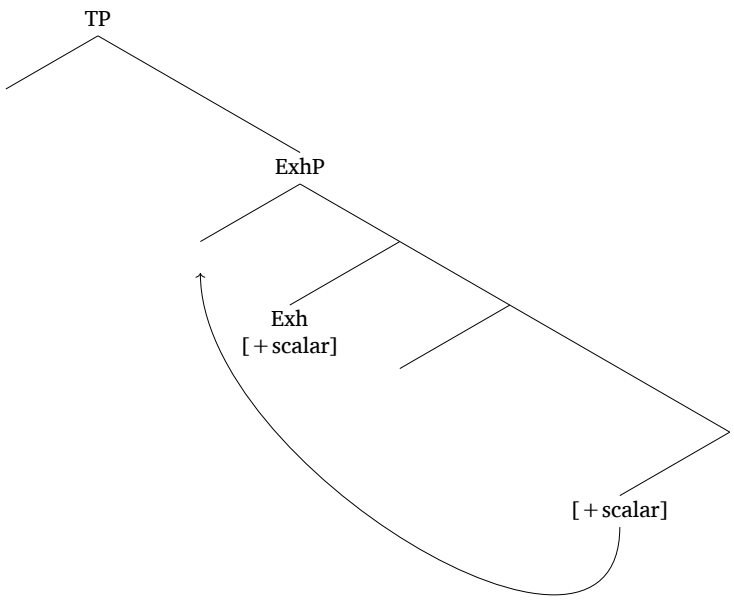
The second point to focus on concerns the functioning of exhaustification. Specifically, I overall adopt Chierchia (2013)'s definition of exhaustification as a feature-checking relation, which is established between the operator (O in Chierchia's terms, Exh in this analysis) and the scalar term in the sentence in virtue of the endowment of both elements of some relevant scale-triggering feature. While Chierchia proposes an articulated bundle of features involved in the derivation, I limit myself to assume the existence of one relevant [scalar] feature: its presence on the operator (probe) is sufficient to trigger the covert movement of the scalar item (goal) and in turn to activate the relevant Horn scale at play in the sentence. Exhaustification is therefore described as a typical case of Agree where the covert displacement of the scalar constituent targets the Specifier of Exh, thus resulting in the typical Spec-head configuration schematically presented in (6):

8. Another possibility is that the exhaustification operator might be located in the left periphery, close to the functional head dedicated to Focus. This hypothesis is based on the interpretive effect of focal stress in a sentence, which automatically presupposes the existence of a set of different possibilities, among which only one is selected (and uttered):

(i) A: So, did you see the students?
B: I saw [$_{F}$ JOE AND SUE]. (only them, and not all of the students)
(adapted from Chierchia, Fox & Spector 2011)

The interpretive closeness with respect to scalar implicatures is clear, such that Chierchia, Fox & Spector (2011) propose that exhaustification might optionally be carried out covertly by focal stress. We do not further explore this possibility for reasons that will become clearer in the discussion.

(6)



This syntactic analysis of scalar implicature derivation can be pushed a step further by appealing to the criterial view proposed by Rizzi (1997; 2013), which is mentioned in the original discussion by Chierchia, but is not expanded as much as it could be. According to the criterial framework, the correct realization of a number of scope-discourse properties (e.g., Topics, Foci) is subject to the fulfilment of dedicated syntactic requirements, i.e., the Criteria, whose realization provides the necessary input for the interfaces: in other words, a syntactic output is the necessary input for the conceptual-intentional interface to obtain the target interpretation, and for the phonological interface to yield the appropriate intonational contour. Each scope-discourse property is thus structurally projected by a dedicated criterial head bearing a distinctive criterial feature (e.g., [Top] for Topics, [Foc] for Foci): such features act as attractors to other syntactic objects in the structure bearing the same relevant trait, thus triggering their movement; then, the attracted constituents raise to the Specifier of criterial heads giving rise to Spec-head configurations in which the displaced phrase remains stuck, unable to move further (Criterial Freezing, Rizzi 2017 a.o.).

In light of these considerations, I argue that SIs belong to the set of properties whose correct derivation depends on a criterial configuration, as well, so that a dedicated Scalar Criterion can be introduced. As all other Criteria, also this one requires that scalar items get attracted by a criterial operator, namely Exh, in virtue of the presence on both elements of a distinctive criterial feature, namely [scalar]. The resulting

Spec-head relation, which in this remains phonologically covert, is then encoded by the semantic interface as a process of exhaustification, and it triggers the familiar interpretive process involving Horn scales.

3.1 The case of <*some,all*> SIs

This kind of criterial interpretation is a very general one, and it does not make any prediction with respect to possible scale-specific requirements: however, the fact that Horn sets are found across a varied range of grammatical categories suggests the possibility that the plain criterial process may be modified by specific grammatical properties of the scalar terms at play in each implicature instance[9]. In the following lines, a finer-grained analysis of the scale of positive quantifiers <*some, all*> will be discussed, while a more complete overview on other scale types is left for further research.

Consider the sentence in (7) as an example of scalar implicature triggered by the scalar term *some*:

(7) a. I saw *some* students.
b. *Scalar interpretation*: I saw *some but not all* students.

The first consideration with respect to the scale at issue is related to the grammatical category it represents: it is a scale of quantifiers. So the correct interpretation of an item like *some* is characterized not only by the definition of its lexical restriction, i.e., the NP it combines with (namely *students* in our working example), but crucially by its nuclear scope too, i.e., the portion of the clause it ranges over. The operation that is traditionally assumed to assign scope to quantifiers is called Quantifier Raising (QR), and it consists in raising such phrase to its scope position in a covert fashion, without any phonological realization of the movement (May 1985)[10]. While there is little doubt about the necessity to postulate the existence of QR, its precise characterization remains a matter of debate due to its hybrid characteristics, only partially similar to the properties of other instances of A'-movement[11].

The most traditional account proposed by May (1985) holds that QR is a free adjunction process that applies uniformly to all quantifier phrases; quantifiers would not be selective with respect to the landing

9. As for other kinds of implicatures, like particularized implicatures, we do not make any assumption here. However, the fact that their realization is much more context-dependent with respect to SIs may reflect a difference in the process of derivation too.
10. See Brody & Szabolcsi (2003) for possible overt manifestation of QR in Hungarian.
11. For a general discussion on the peculiarities of QR and the phenomena that require its existence, see Cecchetto (2004).

site of their movement, such that in principle any non-argumental XP in the structure (though usually restricted to the TP layer) may be exploited as a suitable scope assignment site. A drawback of this account, however, is that it fails to capture the logical-semantic heterogeneity within the class of quantifiers, which surfaces in the fixed, constrained positions that multiple quantifier phrases in the same clause may occupy with respect to each other. These regularities are better captured by the Checking Theory of Scope Assignment developed by Beghelli & Stowell (1997), instead, which assimilates QR to other instances of A'-movement triggered by a feature-checking mechanism and provides a partition of quantifiers into classes based on their logical functions, each characterized by a distinctive feature to be checked on a dedicated head in the clause structure.

Following the intuition according to which scope assignment and logical-interpretive properties influence each other, it is possible to individuate two requirements that the scalar quantifier *some* needs to fulfil for a correct interpretation: on the one hand, it is endowed with a class-specific feature, which is labelled [quant] here for the sake of simplicity, and which individuates the type of quantifier phrase it belongs to. Such trait determines the scope assignment position on a matching functional head Q, also endowed with [quant]: in compliance with Beghelli & Stowell (1997), such QP is located in the TP layer[12]. Moreover, *some* is a scalar quantifier, so it also bears the feature [scalar] which requires checking: that is why it is possible to assume that the head Q is endowed with a [scalar] feature, as well, which makes it a more fitting attractor for the scalar *some*-phrase at issue. The relevant operation of QR can therefore be sketched as follows:

(8) $[_{QP}$ Q $_{[+\text{scalar}, +\text{quant}]}$ $[_{TP}$ I saw [some$_{[+\text{scalar}, +\text{quant}]}$ students]]]]

In light of the previous discussion on the Scalar Criterion, it is natural to wonder how the two operations of QR and exhaustification interact with each other, since they seem to be at play simultaneously in the same portion of the clausal structure, and they involve the same syntactic

12. For the sake of simplicity, I do not use here the precise terminology proposed by Beghelli & Stowell (1997), according to which *some* belongs to the class of Group-Denoting Quantifiers bearing a [group reference] feature and targeting Group-Denoting Quantifier Phrases (GQPs). Moreover, I simply assume that the landing site of such quantifiers is located in the TP area, leaving aside the alternatives individuated in the original work to account for the possibility of these quantifiers to take either narrow scope (ShareP) or wide scope (RefP), and thus target the CP layer. Nevertheless, it is sufficient to note that movement to neither of the two positions would have problematic effects for the general proposal, so I do not discuss this issue further here.

objects. The first issue to deal with concerns the reciprocal position of the two target constituents QP and ExhP in the clause, as both projections are assumed to be located in the TP system and, in principle, either of the two may dominate the other, as in (9) below:

(9) a. $[_{\text{ExhP}}\ \text{Exh}_{\ [+\text{scalar}]}\ [_{\text{TP}}\ \text{T}\ [_{\text{QP}}\ \text{Q}_{\ [+\text{scalar},\ +\text{quant}]}\ \ldots[\text{some}_{[+\text{scalar},\ +\text{quant}]}\ \text{NP}]]]]$

b. $[_{\text{QP}}\ \text{Q}_{\ [+\text{scalar},\ +\text{quant}]}\ [_{\text{TP}}\ \text{T}\ [_{\text{ExhP}}\ \text{Exh}_{\ [+\text{scalar}]}\ \ldots[\text{some}_{[+\text{scalar},\ +\text{quant}]}\ \text{NP}]]]]$

The first possibility is that the configuration in (9a) holds, where ExhP dominates QP. Following this configuration, the *some*-phrase would be attracted and moved to the most local head first, namely Q. There, it would be able to check both [scalar] and [quant], so there would be no reason for it to move further to Exh and satisfy the Scalar Criterion. This is of course an unwelcome conclusion, so this arrangement is ruled out. In (9b), instead, the pattern is reversed and QP is taken to dominate ExhP. This solution is somewhat problematic, as well, because the low position of ExhP with respect to QP suggests the possibility for *some* to be displaced to the closest position with attracting features, namely Exh, which is endowed with [scalar]. There, *some* would not only establish a Spec-head relation and fulfil the Scalar Criterion, but it would also remain stuck due to Criterial Freezing. As a consequence, the quantifier phrase would be unable to move further and check the quantificational feature [quant], thus blocking scope assignment and the target interpretation of the constituent:

(10) $[_{\text{QP}}\ \text{Q}_{\ [+\text{scalar},\ +\text{quant}]}\ [_{\text{TP}}\ \text{T}\ [_{\text{ExhP}}\ \text{Exh}_{\ [+\text{scalar}]}\ \ldots[\text{some}_{[+\text{scalar},\ +\text{quant}]}\ \text{NP}]]]]$

The only solution is to assume the opposite mechanism, where the *some*-phrase moves first to QP, where preliminary crucial information about scope is provided. Moreover, since Q is also endowed with the [scalar] feature, the Scalar Criterion may be satisfied at a distance from the Specifier of Q, which takes on the relevant role of Exh and works as target for both operations. In other words, both QR and exhaustification may be performed jointly through one single covert movement of *some* to the Specifier of its matching quantificational head Q, as shown in (11):

(11) $[_{\text{QP}}\ \text{Q}_{\ [+\text{scalar},\ +\text{quant}]}\ [_{\text{TP}}\ \text{I saw}\ [_{\text{ExhP}}\ \text{Exh}_{[+\text{scalar}]}\ [\text{some}_{[+\text{scalar},\ +\text{quant}]}\ \text{students}]]]]$

The fact that *some* is assumed to move past the operator Exh, which is normally the target for exhaustification via the Scalar Criterion does not represent a locality violation, because the functional head only partially

matches the featural endowment of the moved constituent, which is in fact richer[13].

Reasonably, the same computation also applies to other members of the relevant Horn set at issue here, i.e., *many* and *most*, whose intermediate ranking in the scale reflects an intermediate degree of informativity, and therefore the possibility to trigger a scalar implicature. As regards the quantifier *all*, instead, it is not expected to undergo the same process for two reasons: first, it is the most informative item within the <*some*, *all*> ordering, so it should not trigger exhaustification, and possibly it does not bear a [scalar] feature, either[14]. Second, by rejecting the Scope Uniformity assumption, a natural prediction is that the scope assignment position of *all* is not the same as *some* (i.e., QP), because they belong to two distinct quantifier classes, each characterized by a distinctive feature and scope assignment projection (Beghelli & Stowell 1997).

4 Predictions: Intervention effects in child grammar

Based on the analysis of the interplay between QR and the Scalar Criterion carried out in the previous section, it is now possible to turn to acquisition and child computation of the sentence in (7), reported here as (12) and integrated with child characteristic non-scalar interpretation:

(12) a. I saw *some* students.
b. *Scalar interpretation*: I saw *some but not all* students.
c. *Non-scalar (child) interpretation*: I saw *some and maybe all* students.

Precisely, the idea to hold is that the computation presented in the previous section is representative of adult grammars only, so it may serve as a guide to understand which part of it is beyond children's computational abilities.

13. A similar phenomenon seems to underly the different left peripheral positions targeted by lexically restricted *wh*-items and bare *wh*-items in *wh*-questions: while both of them are characterized by a [Wh] feature, the former is also endowed with an [N] trait, which forces the lexically-restricted *wh*-element undergoing movement to go past the head for bare *wh*-, to a higher landing site with no locality violation (Munaro 1999).
14. This analysis holds in upward entailing contexts. As Chierchia (2004) points out, however, *all* may originate an indirect scalar interpretation in downward entailing contexts, where entailment relations are reversed. This observation suggests that at least in these linguistic environments *all* should bear the [scalar] feature, as well: for the purpose of this work, we will not dig into indirect implicatures, so we leave this issue for further research.

As a first step, it is reasonable to exclude that children at the age of six have troubles with criterial configurations in general. Such possibility does not seem plausible because child language presents several instances of target treatment of criterial properties from a very early age: suffice it to mention child knowledge and satisfaction of the *Wh*-Criterion from around their third year of age[15]. Therefore, I assume that the Scalar Criterion is in principle available for preschoolers too, and that the difficulty related to the derivation of *some*-SIs is embedded in some other computational domain.

Another possibility that comes to mind is that children before school age may struggle with QR: in this sense, the fact that the derivation at issue hinges on the correct treatment of a quantifier may represent a major source of complexity. However, acquisitional studies have consistently shown that around the age of four QR is already mastered, as evidenced by good performance with inverse scope and VP ellipsis reconstruction in antecedent-contained deletion structures (Kiguchi & Thornton 2004; Syrett & Lidz 2009).

It is therefore clear that neither the Scalar Criterion nor QR *per se* are too demanding for pre-schoolers, so none of them can be held individually responsible for the late acquisition of scalar implicatures. This consideration is only valid if the two processes are analysed in isolation, though, while here they both take place together on the same portion of clausal structure: that is why I put forth the hypothesis that complexity is a result of the interaction between the two derivations and the constituents involved in it, and it can be explained in terms of intervention effects as will become apparent in the following lines.

To give a clear account of the proposal, it is useful to observe the featural configuration of the syntactic objects at stake:

(13) $[_{QP}\ Q_{\ [+scalar,\ +quant]}\ [_{TP}\ T\ [_{ExhP}\ Exh_{\ [+scalar]}\ \ldots[some_{[+scalar,\ +quant]}\ NP]]]]$

As it was claimed some lines above, the fact that Exh bears the relevant [scalar] feature while occupying an intermediate position between the origin and the target of the derivation does not represent an issue for locality, because the *some*-phrase is featurally richer; thus, Exh does not disturb SI derivation in adult grammars. However, the partial overlap of features between Exh and Q is likely to have some consequences in the overall complexity of the computation. Following the predictions of Featural Relativized Minimality (fRM, Starke 2001; Rizzi 2004), intervention effects arise whenever a dependency between two elements

15. For a complete review on the acquisition of *wh*-movement and the *Wh*-Criterion across several languages, see the general overview in Guasti (2016).

X and Y is disturbed by a third element Z, such that it structurally intervenes between the two and matches the target of the dependency X with respect to some relevant morphosyntactic features. This condition perfectly conforms with the configuration under discussion, where the covert operator Exh (Z) c-commands the origin of the derivation at issue (Y) while being c-commanded by the target (X) and sharing with it some crucial feature, namely [scalar]:

(14)

X	Z	Y
QP	Exh	*some* NP
[+scalar, +quant]	[+scalar]	[+scalar, +quant]

The computation at issue is not ruled out by grammar because of the feature [quant] on the two ends of the dependency, which breaks the featural identity between X and Z and turns it into a partial overlap: following the set-theoretic schema proposed by Friedmann, Belletti & Rizzi (2009), the derivation in (14) represents an intermediate level of intervention between identity of features, i.e., a completely degraded structure, and disjunction of features, i.e., the optimal configuration:

(15)

	X	*Z*	*Y*	
Identity	+A	+A	<+A>	Strong violation
Inclusion	+A +B	+A	<+A +B>	Weak violation
Disjunction	+A	+B	<+A>	No violation

In this spirit, the only condition that is required by adult grammars to avoid intervention effects is a complete overlap of features, so that even a minimal distinction is sufficient to disambiguate between the two competing constituents, as evidenced by the different types of object A'-dependencies below (16):

(16) a. Object relative: The problem [+R, +N] that the student [+N] solved _

b. Object *wh*-Q: Which problem [+Wh, +N] did the student [+N] solve _ ?

The same, however, does not hold for early grammars, where a stricter application of fRM seems to be at play and even a partial overlap of features between target and intervener is sufficient to make the structure too complex and, in turn, to rule it out. This interpretation has been proposed in the seminal work by Friedmann, Belletti & Rizzi

(2009) to account for the heterogeneous pattern of acquisition of object A'-dependencies observed both in production and comprehension of Hebrew-speaking preschool children. In their study, they observed that only some object A'-dependencies could not be handled, and precisely all the instances in which the extracted object shared some fRM-sensitive feature with the intervening subject, as in object *which* questions with lexical subjects (17a); on the contrary, the same children could master object questions with bare *wh*-items, where no relevant feature is shared between the two competing arguments (17b):

(17) a. [Which dog [+Wh, +N] does [the cat [+N] bite _]]?

b. [Whom [+Wh] does [the cat [+N] bite _]]?

The observation that structures with feature inclusion are temporarily out of reach for child grammars and later accepted by adult systems is taken up in this work too, where it is applied to the domain of scalar implicature derivation. As observed above, the derivation of *some*-SI involves the same featural pattern of object *wh*-questions with a lexically restricted *wh*-item, such that in both cases the dependency is to some extent disturbed by an intervening constituent partially matching the relevant features of the target:

(18) a. [Which dog [+Wh, +N] does [the cat [+N] bite _] ?

b. [$_{QP}$ Q [+scalar, +quant] [$_{TP}$ I saw [$_{ExhP}$ Exh [+scalar] [some students]] [+scalar, +quant]]]

In this sense, the fact that preschool children do not derive *some*-implicatures in the same time window in which object *wh*-questions with lexically restricted *wh*-items are also ruled out is interpreted as an effect of the computational complexity involved in both derivations, which is expressed in terms of intervention effects via featural inclusion.

4.1 Modulation: inclusion to disjunction

The parallel between *some*-SIs and object A'-dependencies suggests the possibility to investigate further the common points of the two structures, particularly with respect to their acquisitional processes. It has been noticed, for instance, that children facing complex object A'-dependencies may benefit from specific expedients that manipulate the relevant featural configuration in order to avoid the complex subset-superset relation.

As an example, comprehension of object dependencies with lexically-restricted subjects and objects is substantially enhanced by the mismatch of some phi-features on the intervening subject and the displaced object (Adani et al. 2010; Belletti et al. 2012; Durrleman & Bentea 2017 a.o.). This small alteration is sufficient to introduce a disambiguating trait on the two competing items, as shown by the below example of an object relative clause in Hebrew[16]:

(19) Tare li et ha-yalda she-ha-rofe mecayer __
Show me ACC the-girl$_{fem}$ that-the-doctor$_{masc}$ draws$_{masc}$
[+R, +N, +fem] [+N, +masc]
"Show me the girl that the doctor draws." (Belletti et al. 2012)

Also, *a*-marking of object Topics in Italian Clitic Left Dislocation performed by young children has been interpreted as a way to avoid inclusion: through the assignment of an affectedness feature ([a]) to the displaced object, it is disambiguated with respect to the unaffected ([u]) subject, and topicalization past the intervener becomes easier (Belletti 2018; Belletti & Manetti 2019):

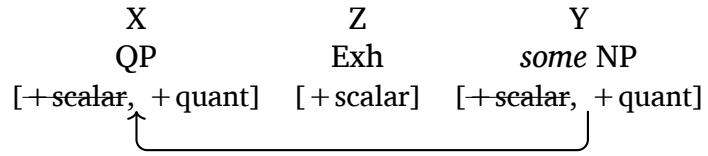
(20) Al re il bambino lo pettina _
To-the king the child him-Cl combs
[+Top, +N, +**a**] [+N, +**u**]
"The king, the child is combing him." (Belletti & Manetti 2019)

Both strategies have the advantage of modulating inclusion complexity for children, by "saving" hard structures and making them accessible. It is therefore reasonable to wonder whether some form of modulation may be recognized in child (lack of) derivation of *some*-SIs, as well: the fact that preschoolers give a correct, though underinformative, interpretation of these structures, together with the experimental evidence showing that QR is not problematic for young children, may be indicative of the fact that the computation does not completely crash, and at least part of it is carried out successfully.

In light of these premises, it is possible to propose that the modulation strategy adopted by children facing feature inclusion induced by the interplay between QR and the Scalar Criterion consists in turning inclusion into disjunction by neglecting the [scalar] trait on the quantifier *some*, thus obtaining the structure in (21):

16. As for the crosslinguistic variability of the facilitating power of phi-features according to fRM predictions, see Belletti et al. (2012).

(21)



By stripping the quantifier of its [scalar] layer, the overall computation is reduced to a simpler case of scope assignment via checking of the [quant] feature, which is performed regularly on QP. In this simplified computation, Exh is deprived of its intervening status because there is no scalar item to analyse any longer, so the fulfilment of the Scalar Criterion is not required either: therefore, not only the scalar features on the two ends of the dependency become irrelevant, but also the disturbing presence of the exhaustification operator between them is dispelled. In this sense, the parallel that was built between *some*-SIs and object *wh*-questions may be strengthened: as much as the target derivation of *some*-SIs resembles the featural configuration of lexically restricted object *wh*-questions, the plain, non-scalar interpretation of *some* syntactically resembles bare object *wh*-questions, where the lexical restriction on the subject originates no intervention.

(22) a. [Whom does [the cat bite _]]?
[+Wh] [+N]

b. [$_{QP}$ Q [$_{TP}$ I saw [$_{ExhP}$ Exh [some students]]]
[+quant] [+scalar] [+quant]

5 Discussion and further developments

The syntactic implementation of scalar implicatures proposed in this work has several theoretical consequences. First of all, assuming the existence of a Scalar Criterion and, more generally, describing the process of exhaustification in syntactic terms, corroborates the characterization of scalar implicatures as a local, incremental process, as already suggested by both theoretical (Chierchia 2004; 2013; Chierchia, Fox & Spector 2011) and experimental studies (Chemla & Spector 2011). Moreover, the idea that the Scalar Criterion underlying these inferences may interact with other syntactic-semantic operations naturally agrees with the observations on the acquisition of SIs, which return a very heterogeneous picture where children start using different kinds of scales in different developmental stages. In this sense, the variations in the age of acquisition may reflect the variations in the degree of complexity underlying the grammatical processes required by each type of scale. For instance,

the fact that numeral scales are mastered earlier than the quantifier scale I have focused on, suggests that, even though both Horn sets are made up of quantificational elements, numerals may involve simpler operations to obtain their target interpretation with respect to <*some, all*>. Such asymmetry may be explained either in terms of differences in the scope assignment operation, where the two types of quantifiers may target distinct positions in the structure, or by appealing to the salience of numbers in the early years of life of children, which may translate into some form of facilitation (Papafragou & Musolino 2003). If this is on the right track, it might be interesting to understand to what extent implicatures triggered by numbers can actually be explained in terms of scalar alternatives or rather as products of world knowledge.

Another crucial point is that the assumption of a Scalar Criterion should underlie the derivation of all scalar implicatures, regardless of the triggering scale and the specific interactions with other structural requirements. As the function of the Criterion has essentially been interpreted as a trigger for the retrieval of the relevant scalar alternatives, the introduction of such grammatical requirement may contribute to shed some light on the distinction between scalar implicatures and other kinds of inferences that are not dependent on lexicalized scales, and that are more deeply anchored to contextual information. A case in point is represented by particularized, ad hoc implicatures: given their early acquisition and the central role of context in their derivation, they are not necessarily expected to involve a criterial operation (Stiller, Goodman & Frank 2015; Foppolo et al. 2021). Another interesting case is then represented by non-canonical lexical scales, that arise in specific circumstances only (Chierchia 2017): in this case too, the extent to which a Criterion may be held responsible for their derivation is not clear, and it would require further study.

Finally, the parallel between SIs and object A'-dependencies may offer new perspectives in the study of language acquisition, and possibly contribute to shed some light on the great variability that has emerged from experimental studies on SIs development. The idea that has been put forth here is that the gradual acquisitional trajectory that characterizes both scalar implicatures and complex object dependencies is the overt effect of a common nucleus of computational complexity that must be mastered in order to derive correctly the two structures, namely feature inclusion. It is reasonable to hypothesize that calculating the relevant subset-superset relation requires a computational effort that goes beyond the resources of young grammars, because it translates into an online comparison between competing representations, which is further made difficult by the structural similarity of such alternatives[17]. While

17. For some speculations on the limitations in the cognitive components that may

its complexity had already been highlighted in more strictly syntactic domains as a prediction of fRM, the attempt to extend it to phenomena at the interface with pragmatics may open new connections between the two very distinct developmental patterns and between traditionally separated linguistic areas of interest, possibly with positive consequences in the study of language impairments too, where featural configurations have already proved to play a crucial role (Grillo 2008).

6 Concluding remarks

In this paper, a development of the grammar-based approach to scalar implicatures put forth by Chierchia (2013) has been outlined and integrated with the criterial view for scope-discourse properties through the introduction of a Scalar Criterion. Focusing on the scale of positive quantifiers $<$*some*, *all*$>$, it has been shown that a syntactic perspective is not only able to capture the interaction between the exhaustification and scale-specific grammatical operations, but it also allows to provide some insights in the process of acquisition of SIs. Precisely, it has been argued that the main source of complexity that hinders child derivation of SIs in preschool years can be described in terms of intervention effects via feature inclusion, just as happens for some, but not all, object A'-dependencies in the same time window. In this sense, this proposal brings closer two linguistic phenomena that are traditionally considered very far from each other, suggesting a common core of computational complexity.

underly the correct handling of feature inclusion, cf. (Friedmann, Belletti & Rizzi 2009)

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