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# Islands, expressiveness, and the theory/formalism confusion

## 1 Introduction

*Subregular linguistics: bridging theoretical linguistics and formal grammar* (henceforth SL) argues that Subregular Linguistics (the application of very restricted subclasses of finite-state machinery to natural language) offers many profitable insights to theoretical linguistics, such as providing a unified view of phonology, morphology, and syntax, leveraging learnability considerations for informing the derivation of typological restrictions, and deriving island constraints from the computational nature of movement. In this commentary piece, we shall focus on island phenomena, and on the role that formalisms play in restricting empirical coverage, and argue that accounting for such phenomena in such a fashion is empirically and methodologically problematic.

## 2 TSL, Movement, and Islands

SL leverages a class of formalism that is classified as Tier-based Strictly Local (TSL), which is claimed to be useful in the modeling of island phenomena because it captures a notion of relativized locality that ignores irrelevant segments in the string. Intuitively, the most recently seen symbols that belong to a specific alphabet are stored in memory, and that sequence is checked against the finite list of forbidden sequences. SL illustrates the value of the TSL-based account on modeling tensed adjunct island violations, like (1).

(1) *Which car does John complain because Mary bought _?
(SL, page 29)

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SL's position is at odds with growing evidence that tensed Adjunct Island violations are graded, and even licit in certain cases. For example, there seem to be no island effects when extraction occurs from adjuncts in relative clauses, as in (2). Example (2a) is a naturally-occurring attestation. See Sprouse et al. (2016) and Gibson et al. (2021) for sentence acceptability studies which found no island effect in such constructions.

(2) a. I got to do things in the film that, [[if you did _ on the street] they'd send you away].
[Dwaine Epstein. 2013 *Lee Marvin: Point Blank*, Schaffner Press]
(Chaves and Putnam, 2021, 91)

b. I called the client who the secretary worries [if the lawyer insults _].
(Sprouse et al., 2016)

c. This is the watch that I got upset [when I lost _].
(attributed to Ivan A. Sag (p.c.) by Truswell (2011, 175, ft.1))

d. Robin, Pat and Terry were the people who I lounged around at home all day [without realizing _ were coming for dinner].
(Levine and Hukari, 2006, 287)

e. This is the house that Mary died [before she could sell _].
(adapted from Grosu (1981, 88))

Moreover, even wh-interrogative gaps inside Adjunct Islands like (1) can be graded, as argued by Kluender (1998), Goldberg (2006, 144), and Chaves (2012, 471). Consider the data in (3). As Chaves and Putnam (2021, 235–239) show, such constructions 'satiate' (Snyder, 2000), i.e. become more and more acceptable with repeated exposure.

(3) a. Which toy did Timmy get really upset [when he lost _]?

b. Which book will Sue understand linguistics better [if she reads _]?

c. Who would Sue be really happy [if she could speak to _]?

d. What would Mia be impressed [if Robin cleaned _]?

e. What did Tom get mad [because Phil forgot to say _]?

Gibson et al. (2021) also show that if a supporting context is provided, then the island effect in such tensed adjuncts is significantly ameliorated.

The extant evidence suggests that extraction from tensed adjuncts is construction-dependent, graded, sensitive to frequency and context, and therefore unlikely to be due to strictly syntactic factors (Deane, 1991; Goldberg, 2006; Chaves and Putnam, 2021; Gibson et al., 2021). For additional experimental evidence that semantic factors are involved in licensing such constructions see Müller (2017a), Bondevik (2018), Kohrt et al. (2020), and Müller and Eggers (2022).

SL also sketches how the Complex NP constraint (CNPC) could be modeled by TSL.[1] Again, there is growing evidence that, under certain conditions, relative clauses do not block movement. The most robust cases come from presentational/existential relative clauses, as in (4). See Goldberg (2006, ch.7) for more discussion, and see Kush et al. (2013), Bondevik (2018), Müller and Eggers (2022), and Vincent et al. (2022) for experimental evidence indicating that such relatives are not island environments.

(4) a. Which diamond ring did you say there was nobody in the world [who could buy _]?
(Pollard and Sag, 1994, 206)

b. This is the kind of weather that there are many people [who like _].
(Erteschik-Shir and Lappin, 1979)

c. Violence is something that there are many Americans [who condone _].
(McCawley, 1981, 108)

d. There were several old rock songs that she and I were the only two [who knew _].
(Chung and McCloskey, 1983)

e. John is the sort of guy that I don't know a lot of people [who think well of _].
(Culicover, 1999, 230)

Various other counterexamples to the CNPC have been noted in the literature, as early as Ross (1967, 139). The examples in (5) serve to illustrate. See Pollard and Sag (1994, 206,207), Kluender (1998), and Sag et al. (2009) for more examples.

(5) a. Which kid did you hear [a rumor [that my dog bit _]]?

b. Which terrorist did you hear [rumors [that the CIA assassinated _]]?

c. What did you get [the impression [that the problem really was _]]?

Snyder (2000, 2017), Hofmeister and Sag (2010, 402–404), and Goodall (2011) also show that CNPC island effects can satiate, and Do and Kaiser (2017) show that CNPC sentences can be primed. This suggests that such constructions are actively built by comprehenders during processing. In sum, no theory (let alone formalism) should categorically ban extractions from relative clauses. SL is not alone in this misguided effort, as we shall see below. For example, Steedman (2001,

1 See Shafiei and Graf (2020) for a worked out formalization of the CNPC in this formalism, among other islands.

59-66) states that adjuncts and relative clauses are islands, and that such island effects neatly fall out as consequences of the rules of Combinatorial Categorial Grammar. Steedman and Baldrige (2011) reiterates the claim that adjuncts are islands but now acknowledges that the CNPC should 'probably be explained in terms of probabilistically or semantically guided parsing rather than in terms of grammar as such.' We hope that, in time, CCG will not claim Adjunct Islands are syntactic phenomena either.

SL concludes that TSL 'produces island effects *for free*' and has 'gotten rid of the puzzle why island effects exist, only to be faced with the puzzle why island effects are so systematic'. We could not disagree more with these statements. SL's TSL account of Adjunct Islands and the CNPC is not only stipulative, it is incompatible with the empirical facts as it wholesale rules out all such extractions. It is unclear how SL can predict the nuanced observed empirical patterns (gradience, satiaton, construction-specificity, contextualization effects, etc.) from independently motivated factors, and explain why things should be as they are.

# 3 Expressiveness

## 3.1 The theory/formalism distinction

We now turn to the core problem with SL, and the line of research from which it ultimately stems. As SL points out, 'Virtually all operations and constraints that Minimalists have proposed can be defined in terms of first-order logic over trees, making it very unlikely that syntax contains phenomena that absolutely cannot be described in first-order logic.' SL proposes to go further, arguing that the formal metalanguage in which the theory is cast should be restricted as well: 'first-order logic can express all kinds of unnatural conditions. For any attested constraint, first-order logic can also enforce its symmetric opposite, e.g. that licensees must c-command their licensors. Attested constraints can be combined via disjunction or implication, most likely yielding highly unnatural patterns. Once again a tighter characterization would be preferable.'

We believe that SL's goal is misguided – as is previous work in a similar vein discussed in §3.2 below – in that it assumes a kind of *naive grammatical realism*: grammar formalisms are taken to be real in some cognitive sense, and to bear some deep relation to the psychology of language. But the assumption of anything 'isomorphic' between the grammars that linguists invent and the linguistic processes going on in the brain is nothing but speculation at this point. Cognitive

neuroscience has not yet found any clear relation between formal grammars and the neural language system.[2]

The second problem with SL's stance is that it confounds linguistic theory with the formalism in which the theory is cast. Chomsky (1965, 62), Chomsky (1981, 277,280), Pollard (1996, 9), Dryer (2006), Müller (2017b, 21) and others note a pervasive confusion in linguistics between the notion of *theory* and its *formalism*. By theory, we mean a particular hypothesis (or system of hypotheses) about a specific phenomenon, such as a theory of electromagnetism, a theory of speech perception, or a theory of natural language syntax. By formalism, we mean the metalanguage in which the theory is articulated. Stated like this, it is obvious that theory and formalism are very different things, subject to different standards of evaluation. A theory of speech perception is not a metalanguage for describing speech perception, rather, it is an idealized hypothesis about what occurs in order for speech perception to take place.

To borrow a thought experiment from Pollard (1996, 9), imagine Einstein's paper on *The Foundation of the General Theory of Relativity* being rejected by the journal's editor not because there's anything wrong with the equations, but rather because Einstein's differential equations are expressed in the first-order language of set theory, a totally unconstrained formalism that can be used to express any computable function. Should Einstein's work be rejected because the author could have in principle written down any set of differential equations? Of course not. Similarly, a linguistic theory should not be rejected simply because of the metalanguage it is expressed in. Chomsky (1965, 62) made this point when discussing the expressiveness of the formalism of the Aspects theory:

> Along this empirically significant dimension, we should like to accept the least "powerful" theory that is empirically adequate. It might conceivably turn out that this theory is extremely powerful (perhaps even universal, that is, equivalent in generative capacity to the theory of Turing machines) along the dimension of weak generative capacity, and even along the dimension of strong generative capacity. **It will not necessarily follow that it is very powerful (and hence to be discounted) in the dimension which is ultimately of real empirical significance.** [emphasis added, C&P]
> (Chomsky, 1965, 62)

In other words, the fact that a formalism can in principle express any computable function does not prevent it from expressing very restricted functions for a given

**2** See for example Blank et al. (2016) and Pylkkänen (2019) for evidence that no singular brain structures are dedicated to syntax, and that all structural processing is highly distributed across multiple areas, in both hemispheres.

domain, of course, and it is the empirical merits of the latter that are relevant to evaluate for said domain. For example, even though programming languages like C, Prolog, Lisp, or Python are extremely expressive, it is possible to write very efficient programs, with extremely restricted expressiveness. And those programs should be judged by their merits, rather than summarily discarded simply because of the expressiveness of the language in which they are expressed.

For example, Collins and Stabler (2016) provide a formalization of the Minimalist Program (MP), and in doing so they employ a very expressive formalism, set theory.[3] Should the MP be disregarded outright because of how unrestricted its formalism is? In our view, no. What matters is the theory, not the metalanguage.

The confusion between theory and formalism not only creates empirical problems for the theory (see §3.2 for more examples) but it also gives apparent license to researchers to dismiss and ignore competing research, without bothering to consider their empirical merits. For example, Hale (2014, 8) dismisses HPSG on the grounds that '(...) a sufficiently expressive formalism can allow the grammar writer to define inferential problems that no parser can solve'.[4] This is a straw-man argument. SL, too, describes HPSG as 'unrestricted', and compares it to the Aspects model, which can generate any computable string language (Peters and Ritchie, 1973). SL adds that 'consequently, there can be no efficient parsing or learning algorithms that work for every Transformational Grammar, which undermines its status as a plausible theory of syntax.' SL correctly spots the fallacy in this argument (at least for Aspects), by noting: 'But Peters and Ritchie's theorem hinges on a particularly liberal use of deletion rules that, albeit technically allowed, does not match the way the formalism was actually used by linguists at the time.'

In our view, neither the MP nor HPSG ought to be summarily dismissed because of how very expressive their metalanguages are. What matters are the theories themselves. The *formalism* that HPSG uses was borrowed from general-purpose Knowledge-Representation systems (Carpenter, 1992), and as such it is very expressive. In fact, its finite model checking problem is undecidable (Kepser and Mönnich, 2003), but that has no bearing on the restrictiveness of the *theory*, as discussed above. The grammars that HPSG researchers actually construct, informed by the empirical observables of the languages they specialize on, are weakly

**3** The Zermelo-Fraenkel set theory (with the axiom of choice), is the axiomatic system used as the foundation of most of modern mathematics. A universal Turing machine can be encoded in this system, or even in far weaker ones, such as small fragments of number theory. As demonstrated by Michaelis (2001), even Stabler's Minimalist Grammars (Stabler, 1997) are far more expressive than will be needed for describing human languages.
**4** See Müller (2017b) for a rebuttal of the supposed issues at stake.

equivalent to far less expressive mechanisms.[5] This ends up striking a balance between the systems' expressiveness and the patterns that a grammar is required to model, and explains why even large-scale HPSGs can be parsed efficiently, at scale. As Carroll (1994) showed, in realistic large-scale HPSG models the relationship between sentence length and parse time is merely quadratic $O(n^2)$.

In HPSG, linguistic expressions are modeled as feature structures, and conditional constraints over such structures specify how they combine with each other. There is a broad set of features and constraints that most of the community agrees on, as exemplified by Müller et al. (2021), a freely available 32 chapter, 1623 page handbook written by over 30 researchers across the globe, detailing the state-of-the-art in HPSG linguistic analysis, from phonetics to pragmatics, covering a wide range of languages. Crucially, the handbook achieves this using *the same* consistent theoretical formulation throughout.

The HPSG research is open to the possibility that different languages may necessitate slightly different features and constraints.[6] The process of theory-building is done mostly bottom-up: analyze each language on its own terms and then compare analyses across language groups to discern what may or may not be universal. For more discussion on this methodological approach, see Müller (2015), which describes a project dedicated to the creation of large-scale computational grammars that share a common 'core' set of constraints. At the time of writing, large HPSG implementations have been developed for German, Danish, Persian, Maltese, and Mandarin Chinese. Smaller grammars are also available for English, Yiddish, Spanish, French, and Hindi. Other large-scale multilingual computational HPSG projects exist, such as the DELPH-IN Consortium, which have grammars for English, German, Japanese, Norwegian, Spanish, among other languages.[7]

## 3.2 Restrictive formalisms and island phenomena

SL's goal of seeking ever more restrictive metalanguages for the description of syntax ultimately stems from a research program introduced long ago, which is similarly intent on explaining away islands as syntactic phenomena.

**5** Although the HPSG formalism can be used to compute any function, an HPSG formalization of English can't be used to instead play chess, or solve differential equations, or implement a universal Turing machine. All it does is English.

**6** This is a possibility that even MP practitioners have entertained in order to account for the vast range of observed typological variation, like Wiltschko (2014).

**7** http://moin.delph-in.net/wiki/FrontPage.

Joshi (1985, 225) aimed to strike a balance between expressiveness and processing: the human language processor should have enough expressive power to capture all extant natural language patterns, while at the same time still permitting efficient sentence parsing time, and learnability. The expressiveness of the formalism must be such that the linguistic theory is unburdened with stipulations (Joshi, 1985, 236). As an example, Joshi (1985, 236) and Weir (1988, 2) point to Kroch (1987) and Kroch (1989) for demonstrations that island constraints like Subjacency (Chomsky, 1973) and the Condition of Extraction Domains (Huang, 1982) (CED; preventing extraction from adjuncts and from subjects) follow from the Tree-Adjoining Grammar (TAG) formalism. In TAG, Subjacency follows given certain assumptions concerning the complexity of TAG elementary trees, and of the TAG derivational system. The definition of the adjunction operation in TAG predicts the impossibility of extracting from adjoining clausal adjuncts, which includes relative clauses. See Rambow and Vijay-Shanker (1998), Frank (2002) and Frank (2006) for a more recent overview and discussion of these (and other) classic island effects that purportedly follow from TAG's machinery.

The problem with this stance – analogous to that of Shafiei and Graf (2020) and SL – is that the supposed island predictions are inconsistent with the empirical facts. For example, Subjacency and the CED are simply not robust constraints on movement. All of the licit sentences in (6) are incorrectly ruled out by Subjacency and/or the CED.

(6) a. Who did you write [a book about [the impeachment of _]]?
(Deane, 1991)

b. It was a new company that Simon spread [NP the rumor that [IP they started _]].
(Hofmeister and Sag, 2010)

c. What did [IP [NP the attempt to find _] end in failure]?
(Hofmeister and Sag, 2010)

d. THIS BOOK she knows [IP who [IP has written _]].
(Erteschik-Shir, 2006)

In (6a,b) we see licit NP extractions from complex object NPs. An attested example is (7), from Chaves and King (2020). For experimental evidence that sub-extractions can obtain high acceptability see Dillon and Hornstein (2013), Tollan and Heller (2016), and Chaves and King (2020). Deeper sub-extractions are possible too, as noted by Ross (1967, 197), Deane (1991, 11), and others.

(7) Which segment do you think it is [time for [another edition of _]]?
[*The Tonight Show Starring Jimmy Fallon*; 2014]

(6c) is a licit NP extraction from a subject phrase, a classic strong island environment which is known to be gradient,[8] and which can satiate to the point of becoming acceptable (Chaves and Dery, 2019; Chaves and Putnam, 2021). As in the case of Adjunct Islands, Subject Islands are not active in relative clauses, as demonstrated by Abeillé et al. (2020). An attested example is shown in (8), and for many others see Chaves and Dery (2019) and Culicover and Winkler (2022).

(8) There are some things which [[fighting against _] is not worth the effort]. (Culicover and Winkler, 2022)

Finally, (6d) is a licit example of a *wh*-island. Counterexamples abound in the literature; see Hofmeister et al. (2007, 2013), Boston (2012), and Abrusán (2014, Ch.4) for arguments that such weak islands are performance effects.

In sum, the empirical facts speak against the classic view that the islands discussed above are categorical syntactic patterns, contra SL and many others. See for example Newmeyer (2016) and Chaves and Putnam (2021, ch.3) for detailed overviews. Such constructions should not be ruled out *a priori* by the formalism in which a theory of grammar is stated, as their oddness is due to more subtle factors which are only now being studied in more detail, using controlled psycholinguistic experimentation. The burden of proof lies with those who choose to cling to the view that such islands are syntactic nonetheless, and must explain why islands are the way they are using independently motivated syntactic means.

# 4 Conclusion

The research program that SL builds on assumes that the ideal grammar formalism should impose restrictive expressiveness on the theory. We argue that such an assumption confounds the notions of theory and formalism, is methodologically problematic, and fails to account for the very theoretical puzzles that it boasts to have solved. The extant available evidence is more nuanced and more complex than SL assumes, given a wealth of empirical and experimental results which show that many island phenomena are construction-specific, and graded, rather than categorical. More broadly, gradience must be integrated and fully appreciated in theory-building efforts (Francis, 2022; Culicover et al., 2022). Instead of vindicating SL's program, the island data refute it, and advise against hasty claims about movement and the role of formalism expressiveness in theory-building.

**8** See Ross (1967, 242), Chomsky (2008, 147,160 ft.39), Sauerland and Elbourne (2002), Haegeman et al. (2013), Chaves and Dery (2014), Villata et al. (2019), and many others.

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