Grammatical constraints and reductionism in sentence processing

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In the keynote article, O'Grady proposes the Amelioration Hypothesis, which consists of two main ideas: (i) what has been traditionally characterized as development of grammatical knowledge is merely a reflection of the language processing mechanism's attempt to maximize its own computational efficiency; (ii) grammatical constraints (e.g., on quantifier scope) that are typically considered as innately given can be *reduced* to constraints on the parsing mechanism, such as strict incrementality and avoidance of operations that are costly for working memory. While reductionist explanations of grammatical knowledge have received much attention in recent years (for review, see Phillips, 2013), the Amelioration Hypothesis makes a strong argument that *all* grammatical constraints must be reduced to cognitive constraints on language processing. This commentary explores the limits of this proposal by taking island constraints as a case study, as this is one of the few domains where explicit grammatical and reductionist accounts have been proposed and tested in psycholinguistic studies. I will illustrate that existing evidence calls reductionist accounts of islands into question, which in turn suggests that constraints on grammatical operations and representations remain important in linguistic theories.

Let us first review grammatical and reductionist accounts of island constraints. Since the seminal work by Ross (1967), structural contexts that block long-distance dependency formation have been widely known as islands. These islands include subject NPs (1a), relative clauses (1b), embedded interrogatives (1c) and adjunct clauses (1d) to name but a few, and much subsequent work in theoretical linguistics has searched for a unified grammatical explanation of why these superficially different structures constitute islands.

(1) a. *Who did [$_{\text{Subject}}$ the sister of __] meet John?
b. *What did John meet [$_{\text{Relative Clause}}$ the girl who bought __]?
c. *What did John wonder [$_{\text{Interrogative}}$ whether his sister bought __]?
d. *What did John laugh [$_{\text{Adjunct Clause}}$ because his sister bought __]?

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While the details of these proposals vary, the grammatical accounts of islands are all alike in attributing island constraints to conditions on formal representations or derivations in syntax (e.g., Chomsky, 1973, 1986; Rizzi, 1990; for review, see Boeckx, 2008), semantics (e.g., Szabolcsi & Zwartz, 1993), or information structure (e.g., Deane, 1991; Erteschik-Shir, 1973). On the other hand, many psycholinguists, including O'Grady himself (O'Grady, 2005), have pursued an alternative approach that attributes island effects to working memory constraints (e.g., Hofmeister & Sag, 2010; Kluender & Kutas, 1993). This so called resource limitation hypothesis emphasizes that islands consist of structural environments that independently demand large working memory resources, and that processing such complex structures and simultaneously forming a long-distance dependency goes beyond the capacity of the language processor.

Notice here that traditional acceptability judgment of islands by themselves do not tease apart the two accounts, because low acceptability of sentences with island violations could be attributed to either ungrammatical representations or processing overload. One may argue that it is critical to investigate whether a long-distance dependency formation in real-time parsing is guided by island constraints, because the resource limitation hypothesis makes specific claims about how islands are derived from memory constraints on parsing. However, most of the psycholinguistic evidence for real-time application of island constraints is consistent with either the grammatical or the resource limitation account. For example, Traxler and Pickering (1996) demonstrated that in sentences like (2a) below, the reading time for the critical verb *wrote* is greater when the filler violates the selectional restriction of the verb (e.g., *city*) than when it does not (e.g., *book*). This plausibility mismatch effect indicates that the parser attempted to actively associate the filler with the verb, and the semantic incompatibility led to the processing difficulty. However, when the critical verb *wrote* was embedded inside a relative clause island (2b), such reading time contrasts disappeared. This avoidance of dependency completion inside islands suggests that the parser respects island constraints in forming long-distance dependencies in real time.

(2) a. …the {book|city} that the author wrote unceasingly and with great dedication about…
b. …the {book|city} that the author [who wrote unceasingly and with great dedication] saw…

Many studies have reported experimental evidence for real time application of island constraints (for review, see Phillips & Wagers, 2007), and it has been shown that L2 learners also respect island constraints during second language processing (e.g., Omaki & Schulz, 2011). However, it is important to note that avoidance of dependency completion inside islands may reflect avoidance of grammatical

constraint violations or of overtaxing working memory; thus, these observations are compatible with either hypothesis.

Two recent studies used experiments in which the grammatical account and resource limitation account make different predictions. First, Phillips (2006) examined processing of subject islands with infinitival clauses (3). Positing a gap inside these subject islands generally causes an island violation (3a), except when the sentence contains another gap, as in (3b). Here, the gap inside the island is parasitic on the grammatically licensed gap outside the island, such that the island violation can be effectively repaired.

(3) a. *What did [$_{\text{Subject-Island}}$ the attempt to repair ___] ultimately damage the car?
b.$^{\text{OK}}$What did [$_{\text{Subject-Island}}$ the attempt to repair ___] ultimately damage ___?

Under the resource limitation account, given that subject islands incur island violations as in (3a), those islands must constitute a complex structural environment that is taxing enough to prevent long distance dependency formation. This predicts that regardless of the possibility of rescuing the structure with a subsequent grammatical gap, the parser should always avoid completing a filler-gap dependency inside such subject islands. Contrary to this prediction, Phillips (2006) observed plausibility mismatch effects inside subject islands with infinitival clauses that are similar to (3a). This suggests that the parser completed long-distance dependencies in these islands, knowing that, in principle, the potentially illicit gaps can be grammatically licensed. It is unclear how the resource limitation hypothesis accounts for why dependency completion is possible in these particular subject islands while they must also be taxing enough to cause an island violation as in (3a).

The second argument against the resource limitation hypothesis comes from the observation that working memory capacity, which is known to vary across individuals, does not account for the distribution of island violations. The resource limitation hypothesis predicts correlations between individual working memory capacity and acceptability judgment on island violations, because island violations are supposed to occur when the relevant dependency formation yields processing costs that go beyond the limited working memory capacity. If this is the case, then individuals with lower working memory span should experience island violations more widely and severely than individuals with higher working memory span. Sprouse, Wagers and Phillips (2012) investigated this question with a large-scale acceptability judgment study on a variety of island violations (with over 300 participants), using two measures of acceptability judgment (7-point scale and Magnitude Estimation) and two working memory span tasks (*n*-back and serial recall tasks). The results were striking: the working memory span measures

accounted for 0 to 3% of the island judgment data, suggesting that there is no correlation between working memory capacity and island violations.

These observations corroborate theories in which islands are implemented as constraints on grammatical representations. Moreover, the evidence that islands cannot be reduced to cognitive constraints casts doubt on the proposal that the general linguistic system can be explained without grammatical constraints. Of course, this should not be taken to undermine the value of exploring cognitive factors as potential sources of simplifying grammatical theories. Theoretically speaking, reduction of complex grammatical theories to simpler/fewer grammatical principles or domain-general cognitive constraints is always a welcome result. However, the scope facts discussed by O'Grady are perhaps not sufficient for endorsing the optimism for eliminating the rich grammatical representations and constraints that were uncovered in the last 60 years of linguistics research.

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