(Valian 2009, p. 19). Given the diversity of syntactic features and categories in languages discussed by E&L, there would need to be numerous relative universals to accommodate them. However, the child will need to process the input to determine which were relevant to the target language.

Many researchers in the field reject the formal UG approach; they do not assume domain (language)-specific constraints to facilitate language acquisition. Rather domain-specific knowledge emerges as a product of development. Their concern is with the mechanisms, processes, and strategies involved in acquiring a language or languages. The assumption is that language development cannot be isolated from the child's brain development or social and cognitive development. In the emergentist approaches, language structures are not innate; they emerge from known processes linking "a growing understanding of the brain with new theories of cognition" (MacWhinney 1999, p. xvii). The child uses the cues available in the input to identify the language specific patterns (Bates & MacWhinney 1987), with some cues more reliable than others. In constructivist usage-based approaches, children are assumed to build up syntactic categories and structures of their language gradually, using cues such as frequency and regularity of specific constructions (e.g., Lieven et al. 2003; Tomasello 2003a; 2009). Instead of assuming that the input lacks sufficient cues for the child to acquire the language, the research focuses on which cues it *does* provide and the cognitive and perceptual tools brought by the child to the task of acquisition.

A large proportion of the research designed to test proposed UG principles has focused on complex syntax. However, by the time children are processing complex structures, they have vast experience with their language and the contexts of use. In developing a language, new knowledge is built on existing knowledge. In the initial stages, perceptual biases, attentional mechanisms, and cognitive abilities are involved in processing the rich information provided in the input language. Rhythmic and distributional information provide cues to segmentation (Jusczyk 1997; Werker & Curtin 2005; Werker & Tees 1984). Research on statistical learning (e.g., Saffran et al. 1996) shows that young infants are sensitive to language-specific transitional probabilities, correlational probabilities, and distributional features of the input (Höhle et al. 2004; Mintz 2006; Thiessen 2009). The developing sensitivities allow for segmentation of syllables, words, and other grammatical units of the input language, segmentation that is an essential precursor to acquiring the system. As shown by Kuhl (2004), as infants become attuned to the sound contrasts of their environmental language, reorganisation of their perceptual abilities takes place; similarly, infants' developing statistical knowledge influences what they later perceive from the input. Thus, knowledge is advanced as they map sound sequences to meaning and retain these mappings in memory (e.g., Hollich et al. 2000) and as they identify category membership, for example, by linking the language context to properties of referents in particular domains (Smith 1999). Similarly, in the later stages of acquisition, knowledge of language structures gained facilitates the acquisition of new knowledge.

Phonological memory is important in forming mental representations of new words (Gathercole & Baddeley 1989), and vocabulary development is a precursor of vocabulary development (Bates & Goodman 1999). By assuming that language acquisition is guided by universal principles specific to the language domain, as in the UG approach, the role of cognitive skills and the influence of individual cognitive abilities on language development are not adequately considered. However, the link is clear from typical language development as well as atypical, an example of which is specific language impairment (SLI). It was first proposed that SLI supports separation of language from other cognitive domains, and explanations for language problems in SLI were related to principles of UG (e.g., Rice & Wexler 1996). Although children identified as having SLI are judged to have nonverbal abilities in the normal range, a significant body of research has revealed memory and information processing deficits (e.g., Archibald & Gathercole 2007; Bavin et al. 2005; Montgomery et al. 2009). In addition, significantly lower scores on standardised cognitive assessments are typically reported for SLI groups compared to age-matched, non-impaired children. Thus, an alternative explanation is that cognitive deficits lead to difficulty in processing information from the input, information required in acquiring the language (Leonard et al. 2007).

Theorists need to understand more about the diversity of languages, such as discussed by E&L, and the impact that such typological features have on the acquisition process; and, in addition, develop a greater understanding of language in atypical situations. Such understanding can only advance discussion about constraints on human language.

Unveiling phonological universals: A linguist who asks "why" is (inter alia) an experimental psychologist

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Abstract: Evans & Levinson (E&L) are right to hold theories of language accountable for language diversity, but typological data alone cannot determine the structure of mental phonological grammars. Grammatical universals are nonetheless testable by formal and experimental methods, and the growing research in experimental phonology demonstrates the viability of a comparative experimental evaluation of the Universal Grammar (UG) hypothesis.

There is little doubt that the twin challenges of language universals and language diversity are critical for understanding the architecture of the language faculty, its domain-specificity and evolutionary origins. Despite their crucial import, these questions remain unaddressed in most existing psycholinguistic research. Evans & Levinson (E&L) should be commended for reminding the cognitive science community of its outstanding intellectual debt in this area. Nonetheless, E&L's own conclusion – that the hypothesis of universal grammar is false – does not follow from the evidence they present. Here, I specifically consider E&L's analysis of phonological universals – the role of syntactic and semantic universals falls beyond the scope of this commentary.

In its bare minimum, the hypothesis of Universal Grammar (UG) states that the brains of all speakers represent a shared set of grammatical constraints. Although this hypothesis is often associated with the claims that UG constraints are innate, and domain- and species-specific, these additional claims are not logically linked to the basic hypothesis of grammatical universals. E&L appear to reject all four claims on the grounds that language typology exhibits no absolute, exceptionless regularities. Typological universals, however, are distinct from grammatical universals, and the link between them is complex. Grammatical universals – the object of cognitive inquiry – are mental representations (I-language), whereas typological universals are statistical generalizations concerning external linguistic outputs (E-language). Such outputs are shaped by multiple factors, of which putative grammatical universals are only one force – the restrictions on perception, motor control, conceptual structure and memory, coupled with cultural and social factors, are equally strong determinants.

Consider, for example, the typological prevalence of CV syllables (discussed by E&L). One theory of UG, Optimality Theory

(Prince & Smolensky 1993/2004), attributes this fact to a universal, but violable, well-formedness constraint that requires all syllables to begin with an onset. Such a constraint, however, does not guarantee that CV syllables are most frequent typologically (typological frequency is also determined by extra-grammatical factors); nor does it preclude the existence of onsetless syllables (e.g., V – such syllables can be protected by other constraints enforcing faithfulness to grammatical inputs). Instead, the Onset constraint predicts that no grammatical process will actively transform syllables with an onset to onsetless ones (de Lacy, 2008). Whether the case of Arrernte (cited by E&L) counters this prediction is debatable (Berry 1998; Smith 2005), but typological frequency alone clearly cannot decide this matter.

Although this conclusion calls for a more careful interpretation of the typological diversity, it does not render the UG hypothesis unfalsifiable: optimality theory asserts that universal well-formedness constraints are active in the grammars of all speakers, irrespective of whether the relevant structures are present or absent in their linguistic experience. This strong hypothesis has sparked a productive research program that uses experimental tools to test the role of grammatical language universals – an enterprise that has unfortunately gone unnoticed by E&L. The available findings suggest that speakers are sensitive to putatively UG restrictions unattested in their language while ignoring other regularities that are equally motivated on statistical and phonetic grounds (Becker et al., submitted; Davidson 2006; Hayes et al., submitted; Moreton 2008; Wilson 2006).

Consider, for example, the restrictions on onset clusters (e.g., *bl* in *blocks*). It is well known that onsets such as *bl* are typologically more frequent than *lb*, and languages that tolerate syllables like *lba* tend to allow *bla*. This fact is attributed to sonority – a scalar property that correlates with the intensity of consonants: least sonorous (softest) on the scale are stops (e.g., *b,d*), followed by nasals (e.g., *n*) and liquids (e.g., *l*). Accordingly, *bla* rises in sonority, whereas *lba* manifests a sonority fall. The typological preference for onsets like *bl* is captured by a scalar UG constraint that favors onsets with large sonority distances (e.g., *bl*>*bn*> *bd*>*lb*, where>indicates preference; Clements 1990; Smolensky 2006).

Although sonority restrictions are widely documented, the typological evidence reflects only implicational tendencies, and many languages manifest outright reversals (e.g., Russian allows sonority falls, e.g., *lb*). Such observations might lead E&L to conclude that sonority restrictions are not grammatical universals, but rather, artifacts of modality-specific acoustic and articulatory preferences. However, sonority-based restrictions have been documented in sign languages (Corina 1990; Sandler & Lillo-Martin 2006), and recent experimental work suggests that they are active in the brains of individual speakers even when the relevant structures are absent in their language. English speakers, for example, favor syllables that rise in sonority (e.g., *bnif*) compared to sonority plateaus (e.g., *bdif*), which, in turn, are preferred to sonority falls (e.g., *lbif*), and this preference shapes the perception of these syllables (Berent 2008; Berent et al. 2007): the worst-formed onsets of falling sonority (e.g., *lbif*) are more likely to be misperceived (as *lebif*) compared to sonority plateaus (e.g., *bdif*), which, in turn, are misperceived relative to sonority rises (e.g., *bnif*). The misperception of ill-formed onsets is not due to an inability to extract their surface form from the acoustic input (e.g., it obtains with printed materials; Berent et al. 2009); nor is it explained by the statistical properties of English – similar results have been reported among speakers of Korean, a language that arguably lacks onset clusters altogether (Berent et al. 2008). Instead, these systematic misperceptions imply broad grammatical knowledge that triggers the active recoding of ill-formed structures. The convergence of sonority preferences across phonological systems, both spoken and signed (Sandler 1993), is consistent with a domain-specific phonological mechanism.

Nonetheless, the present results cannot determine whether phonology preferences are, in fact, universal or innate. Markedness (i.e., well-formedness) hierarchies, such as sonority, could vary in detail due to both predictable grammatical processes (e.g., conflation; de Lacy 2006) and variation in fine-grained phonetic properties that could inform their inference (Hayes & Steriade 2004). Whether phonological markedness hierarchies are experience-independent or learned is unknown, and there is vanishingly little information on their domain- and species-specificity. Far from being untestable, however, these questions call for a comparative cross-linguistic research program that combines typological, formal, and experimental methods. The emerging field of experimental phonology demonstrates the viability of this approach in evaluating the UG hypothesis.

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Language evolution: Two tracks are not enough

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Abstract: This commentary argues that Evans & Levinson (E&L) should expand their two-track model to a three-track model in which biological and cultural evolution interact with the evolution of an individual's language repertories in ontogeny. It also comments on the relevance of the argument from the poverty of the stimulus and offers a caveat, based on analogous issues in biology, on the metaphor of language as a container, whether of meanings or of other content.

I welcome the arguments of Evans & Levinson (E&L) and offer only some supplementary remarks perhaps relevant to the future elaboration of their case. I strongly agree that, given the shared properties of the world we live in, our appeals to innate concepts and structures should be a last resort. My primary recommendation is that they expand their model from two tracks to three, so that they can deal with the ways in which biological and cultural evolution must necessarily interact with the evolution of an individual's language repertories in ontogeny. I also comment on the relevance of the argument from the poverty of the stimulus, and I offer a caveat, based on analogous issues in biology, on the metaphor of language as a container of meanings or other content. I have elsewhere addressed related issues, including the primacy of behavior in shaping brain structure (Catania 2008), the interpretation of learning in terms of selection rather than in terms of associations (Catania 1995; 2003; Catania & Shimoff 1998), and the distinction between language structure and function and its implications (Catania 1973; 1990; 2001; 2004; Catania & Cerutti 1986).

E&L make a persuasive case for the interaction of biological and cultural evolution. But languages can survive only if acquired and maintained by individuals who then pass them on. This acquisition and maintenance involves a third variety of selection operating on individual behavior, at every level: from the shaping of complex vocalizations as the child masters phonetic structures, through the semantic and syntactic details of those languages, to the sophisticated social interactions of mature speakers. Without selection at the level of individual language repertories, those linguistic and social practices cannot last long enough to be transmitted across successive generations. For this to work, by the way, ontogenetic and cultural selection must operate upon similar kinds of linguistic units; what is acquired in learning must share dimensions with what is culturally transmitted.