John Benjamins Publishing Company

The importance of input representations

Jeffrey Lidz and Laurel Perkins
University of Maryland

Language learners use the data in their environment in order to infer the grammatical system that produced that data. Yang (2018) makes the important point that this process requires integrating learners' experiences with their current linguistic knowledge. A complete theory of language acquisition must explain how learners leverage their developing knowledge in order to draw further inferences on the basis of new data. As Yang and others have argued, the fact that input plays a role in learning is orthogonal to the question of whether language acquisition is primarily knowledge-driven or data-driven (J. A. Fodor, 1966; Lidz & Gagliardi, 2015; Lightfoot, 1991; Wexler & Culicover, 1980). Learning from data is not incompatible with approaches that attribute rich initial linguistic knowledge to the learner. On the contrary, such approaches must still account for how knowledge guides learners in using their data to infer a grammar.

Yang discusses three computational models that together paint a fuller picture of how learners use their input in grammar acquisition. But this picture is still missing a critical piece: how the learner's input is perceived, and what role immature perceptions play in the learning process. We argue that Yang's strategy of abstracting away from the learner's representation of the input leaves out the role of development, and as a result, may miss important generalizations about language acquisition.

Yang's variational model addresses one way in which language acquisition is incremental: children must learn from one sentence at a time. This model describes how learners might update their probabilities over possible grammars as they receive their input sequentially. But the incremental nature of language acquisition runs deeper. The way that learners perceive their input changes as their grammatical knowledge develops, and these perceptions determine what can and cannot be learned (Gagliardi & Lidz, 2014). For example, before children can identify the category "verb" in their input, that input is not useful for evaluating whether their language has verb raising. But learning cannot wait until children can veridically parse every sentence they hear; in this case no learning would be

necessary (J. D. Fodor, 1998; Valian, 1990). Instead, children must parse their input as best they can with their developing linguistic knowledge, and those partial and immature parses are the input to a learning mechanism. This raises the question of how learners avoid being misled by incomplete or incorrect representations of their input.

This issue can be seen in the following example. Infants make inferences about verbs' meanings and argument structure on the basis of observing how they distribute in transitive and intransitive clauses (Fisher, Gertner, Scott, & Yuan, 2010; Lidz, White, & Baier, 2017). But reliably perceiving those distributions is not trivial, given the variability in how transitivity can be realized:

(1)   Amy fixed her bicycle.

(2)   *Amy fixed.

(3)   What did Amy fix?

Recognizing that (3) is underlyingly transitive depends on knowing that *what* acts as the verb's object, despite not being realized in an argument position. A child who does not yet know that *what* is a *wh*-word might fail to represent it as an argument and treat the verb as intransitive. This could lead to faulty inferences about the argument structure and meaning of *fix*: a learner might think that this verb can freely occur without a direct object.

In considering the problem that clause types like *wh*-questions pose for grammar learning, Pinker (1984) proposed that learners must somehow filter out these sentences at stages of development when they cannot parse them accurately. This introduces a separate problem of how learners know which sentences to filter out. Perkins, Feldman, & Lidz (2017) demonstrated that a learner that expects error in its sentence representations can learn how much data to filter in order to identify the transitivity of verbs in child-directed speech, without knowing in advance which sentences were parsed inaccurately.

Thus, in order to ask how a learner's input provides relevant evidence for evaluating grammatical properties, we must ask how that input is perceived at the relevant point in development. Yang proposes that certain types of evidence would allow a learner to disambiguate between different grammars of argument drop (example 18, p. 688). For example, null objects are an unambiguous cue for a Chinese-type grammar, and occur in high enough proportion in speech to Chinese-learning infants to enable the acquisition of topic-drop at an early age. But this analysis does not account for how infants come to represent null objects in sentences that contain them. It also does not explain how English-learning infants rule out null objects in sentences like (3). If English-learning infants consider an object-drop analysis for these sentences, they might take them as evidence for

a topic-drop grammar. However, if learners use a mechanism like filtering to deal with expected error in their own sentence perceptions, both English- and Chinese-learning infants might be cautious about when they draw inferences from sentences that are missing objects and what inferences they draw.[1] In this case, sentences with missing objects – regardless of whether they actually contain object drop – might *not* be trusted as good evidence for inferring a grammar of argument-drop. Learners' developing perceptions of their input interact non-trivially with the way that they use that input for learning.

The case of dative generalization and retreats raises an extreme version of this concern about the child's perception of her input. Yang's analysis depends upon the accurate perception of the semantic properties of the verbs independent of their syntax, percepts that are not likely to be possible given the messy relation between event perception and linguistic description.

The problem under consideration is (a) what allows children to overgeneralize the use of the double object construction (DOC) and (b) what subsequently allows them to retreat from overgeneralization. According to the Tolerance Principle, learners will link the DOC to the semantics of caused possession. As they acquire more verbs indicating caused possession that do not occur in the DOC, the Sufficiency Principle will cause learners to retract the link between DOCs and caused possession.

This elegant solution depends on the learner having accurate perceptions of caused possession. But how can caused possession be tokened in events, so that learners can formulate the relevant hypothesis about how to subcategorize ditransitive verbs? Since the link between caused possession and the DOC is what is to be acquired, the learner cannot use the fact that a verb occurs in that construction as evidence for its meaning. Instead, the learner would have to use information about the events described by the sentences containing that verb. But, caused possession in the world looks a lot like change of location. If John throws the ball to Mary, it will usually be true that Mary comes into possession of the ball. However, *throw* only implies caused possession in the DOC. The conceptual perspective on the event is dependent on the sentence used to describe it. The same event in the world can be construed as a change of possession or a change of location. Similarly, whereas only *tell* involves caused possession, all telling events are also sayings, and

---

1. There might be an interesting connection between a learner's degree of trust in her input and the parameter γ in Yang's variational model. This parameter represents "the magnitude of probability adjustment as the result of analysis" (p. 669), which Yang attributes to individual extra-linguistic cognitive factors. But the degree to which learners update their grammatical beliefs on the basis of input may also depend on how much error they expect in their input representations, given their current linguistic knowledge.

the vast majority of sayings are also tellings. So, if the caused possession meaning component isn't uniquely identifiable by nonlinguistic perception, any learning theory based on that perception cannot be correct (Gleitman, 1990).

Second, this learning theory would allow for a greater variation than is found among the world's languages. While the theory identifies rule-like links between the DOC and caused possession, the very same system could acquire a language where the prepositional dative was associated with caused possession. But this is not how languages work. If a language has two ditransitive constructions, the one expressing caused possession is always the one in which the goal c-commands the theme (Harley, 2002). And, children know this link despite a severe poverty of evidence (Viau & Lidz, 2011).

The solution to the problem of identifying subcategories of ditransitive verbs fails in two respects. It provides the learner with unrealistic input, since the relevant meaning components are not identifiable based on observations of the world. And, it fails to take advantage of cross-linguistically stable properties that give the learner some purchase on matching sentences to interpretations.

Yang's work illustrates the critical importance of making precise models of how the input is taken in and used for updating grammatical representations. Such precise models, by requiring researchers to provide rigorous analyses of how input drives the growth of grammar, can help to narrow the divide between usage-based and nativist approaches. In building such models, it is important to provide realistic assessments of what children can represent in their linguistic and extralinguistic environments and how these representations feed forward for learning.

Funding

References

Fisher, C., Y. Gertner, R. M. Scott, & S. Yuan. (2010). Syntactic bootstrapping. *Wiley Interdisciplinary Reviews: Cognitive Science*, 1(2), 143–149. https://doi.org/10.1002/wcs.17

Fodor, J. A. (1966). How to learn to talk: Some simple ways. In F. Smith & G. A. Miller (Eds.), *The genesis of language: A psycholinguistic approach* (pp. 105–122). Cambridge, MA: MIT Press.

Fodor, J. D. (1998). Parsing to learn. *Journal of Psycholinguistic Research*, 27(3), 339–374. https://doi.org/10.1023/A:1023255705029

Gagliardi, A., & J. Lidz. (2014). Statistical insensitivity in the acquisition of Tsez noun classes. *Language*, 90(1), 58–89. https://doi.org/10.1353/lan.2014.0013

Gleitman, L. R. (1990). The structural sources of verb meanings. *Language Acquisition*, 1(1), 3–55. https://doi.org/10.1207/s15327817la0101_2

Harley, H. (2002). Possession and the double object construction. *Linguistic Variation Yearbook*, 2(1), 31–70. https://doi.org/10.1075/livy.2.04har

Lidz, J., & A. Gagliardi. (2015). How nature meets nurture: Universal grammar and statistical learning. *Annu. Rev. Linguist*, 1(1), 333–353.
https://doi.org/10.1146/annurev-linguist-030514-125236

Lidz, J., A. S. White, & R. Baier. (2017). The role of incremental parsing in syntactically conditioned word learning. *Cognitive Psychology*, 97, 62–78.
https://doi.org/10.1016/j.cogpsych.2017.06.002

Lightfoot, D. (1991). *How to set parameters: Arguments from language change*. Cambridge, MA: MIT Press.

Perkins, L., N. H. Feldman, & J. Lidz. (2017). Learning an input filter for argument structure acquisition. In *Proceedings of the 7th Workshop on Cognitive Modeling and Computational Linguistics*. https://doi.org/10.18653/v1/W17-0702

Pinker, S. (1984). *Language learnability and language development*. Cambridge, MA: Harvard University Press.

Valian, V. (1990). Logical and psychological constraints on the acquisition of syntax. In L. Frazier & J. G. De Villiers (Eds.), *Language processing and language acquisition*. Dordrecht: Kluwer. https://doi.org/10.1007/978-94-011-3808-6_5

Viau, J., & J. Lidz. (2011). Selective learning in the acquisition of Kannada ditransitives. *Language*, 87(4), 679–714. https://doi.org/10.1353/lan.2011.0088

Wexler, K., & P. Culicover. (1980). *Formal principles of language acquisition*. Cambridge, MA.

Yang, C. (2018). A formalist perspective on language acquisition. *Linguistic Approaches to Bilingualism*, 8(6), 665–706.

Address for correspondence

Jeffrey Lidz
Department of Linguistics
University of Maryland
1401 Marie Mount Hall
College Park, MD 20742

jlidz@umd.edu
https://orcid.org/0000-0001-8829-1495

Co-author details

Laurel Perkins
Department of Linguistics
University of Maryland
1401 Marie Mount Hall
College Park, MD 20742

perkinsl@umd.edu

Publication history