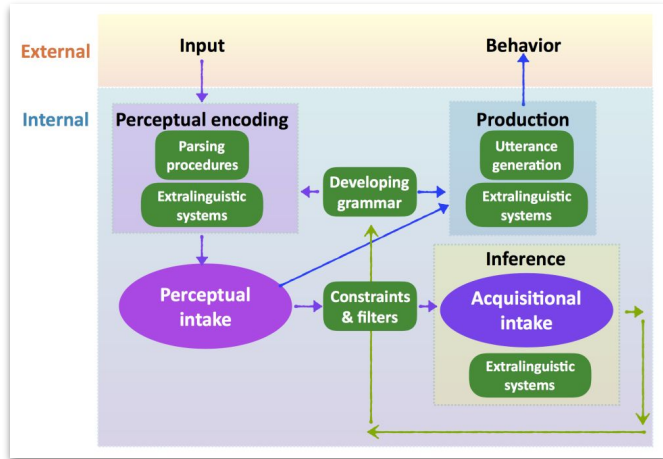
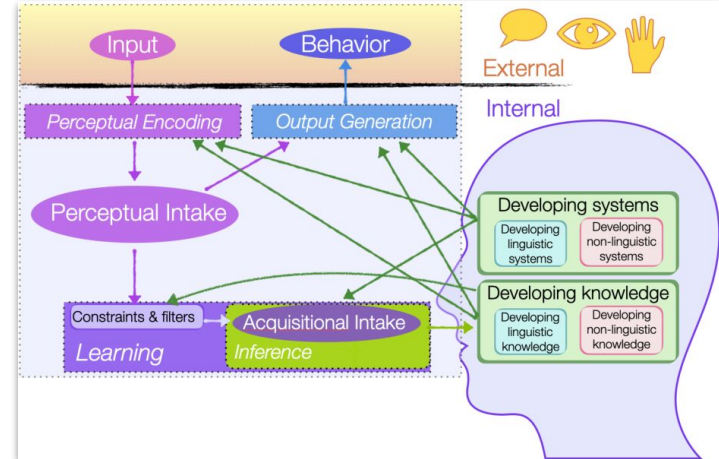


Characterizing acquisition cont.

Old model



New model

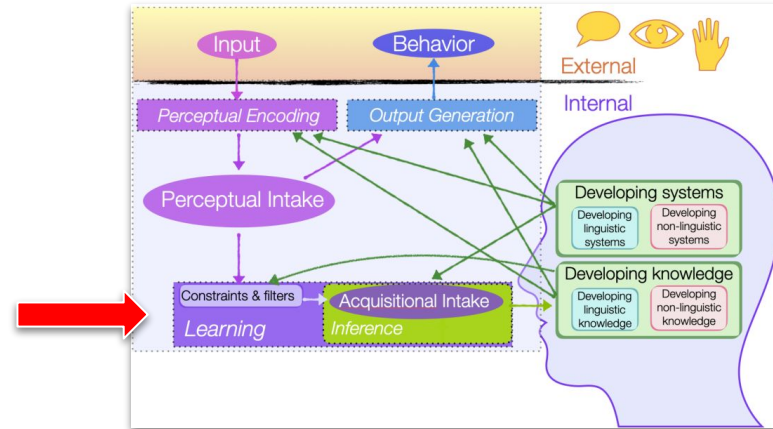


What's going on?

Pg 5

What to learn from: The acquisitional intake. We then get to the **acquisitional intake**, which is the information that children actually learn from. At this point, there's an additional key transformation. The basic idea is that children don't learn from all the information they can perceive. So, for instance, even if they can perceive all the words in the utterance from before, it may be less relevant that individual words are present in the speech stream (e.g., *why, did, you, think*) if children are fairly confident about their speech segmentation. Instead, if children are still learning about the distribution of *wh*-dependency structures in their language, what may be more relevant are characteristics of the *wh*-dependency in that utterance. These characteristics include the structures the words are part of (e.g., CP, IP, VP, etc.) and where the *wh*-word *why* is interpreted (e.g., in the VP with *think* as opposed to the VP with *draw* or the VP with *paying attention*). This is where the **constraints & filters** of Figure 1 come in: focusing the child on the relevant information in the perceptual intake, given the current stage of acquisition.

Importantly, what's perceived as "relevant" depends on what children are trying to learn, and what hypotheses they're considering. In terms of the proposal in Figure 1, constraints can help define what hypotheses are worth considering (that is, how the child's hypothesis space should be usefully constrained: Heinz & Rawski 2024). For instance, in our *wh*-question example, sup-



Back to the acquisition

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Back to acquisition theorizing. My goal in walking through the details of this proposal about the acquisition process was to highlight both (i) the factors that we should consider when building our acquisition theories, and (ii) how complicated it can get. One striking thing (to me) about Figure 1 is how connected everything is (i.e., there are a lot of arrows). We might reasonably wonder if we can make any progress at all on theorizing with this kind of interconnectivity present – that is, until we know for sure about factor X (e.g., developing systems), how can we possibly say anything sensible about factors Y and Z (e.g., perceptual encoding, inference) that depend on factor X?

In response to this question, I (currently) feel that quantitative approaches like mathematical learnability and computational modeling have the right idea: we have to idealize somewhere to get anywhere. Perhaps we ignore (for now) the impact of certain factors. Or, perhaps we simplify

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syntactic elements (pronoun interpretation).

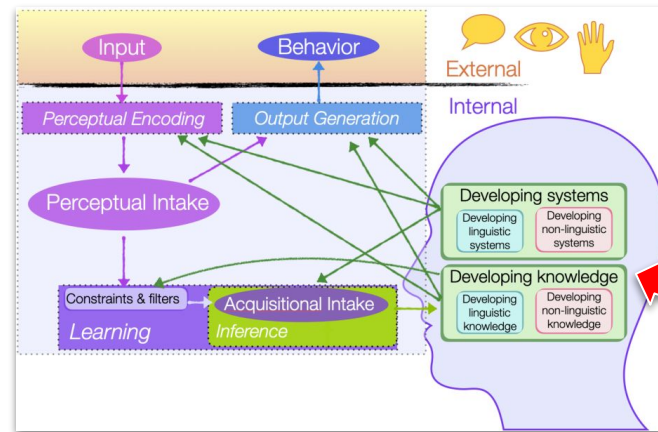
In general, I think questions of *how* acquisition works and *why* children behave as they do are much easier to investigate with modeling. This is because the underlying factors that impact how acquisition works (and therefore why children behave as they do) can be explicitly defined and manipulated within a computational cognitive model. Such factors include how information from

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With that said, informative models typically build on data collected with other techniques. Model input is based on estimates of the information children encounter in their language interactions. Model learning mechanisms are based on ideas of what abilities and learning biases children demonstrate at certain ages. Model output is based on data collected from children (or that can be collected in the future), so that the model can explain children's observed linguistic behavior.

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Perceptual encoding draws on the child's developing knowledge and systems to extract information. For instance, in our example utterance, the child may be able to perceive syllables (e.g., /li/, /sə/, /sɛŋ/, etc.), words (e.g., *Lisa*, *sang*, etc.), syntactic structure (e.g., [_{IP} Lisa [_{VP} sang [_{PP} to [_{NP} the triplets]]]]), pronoun interpretations (*she=Lisa*), as well as the event participants (*Lisa*, the triplets) and properties of the events described (singing, napping), among many other types of information. What children can perceive depends on what they know about their language (e.g., developing linguistic knowledge: *Lisa*, *the triplets*, and *she* are words), what they know about the world (e.g., developing non-linguistic knowledge: who's likely to take a power nap), and how well they can extract information of different kinds (e.g., developing linguistic systems: speech segmentation, syntactic parsing, pronoun interpretation biases; developing non-linguistic systems: memory, cognitive inhibition). Notably, extracting information from the input signal involves ig-

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With these considerations in mind, an acquisition theory can try to provide an explanation at different levels in the sense of Marr (1982): **computational, algorithmic, and implementational** (Pearl, 2023b). In my experience, computational-level acquisition theories are committed to the specified mental computations being performed (e.g., Bayesian inference over a certain acquisitional intake), but not necessarily committed to actual children performing them the way the modeled child does. Ideal/rational learner models (e.g., Foraker et al., 2009, Hsu & Chater, 2010,

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4.1 Building better models

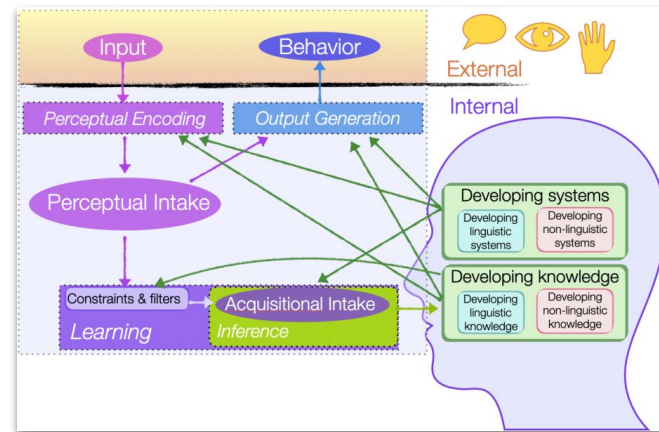
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To **build a computational cognitive model of language acquisition**, we need to be very precise about the acquisition process the model is implementing. One concrete proposal for the relevant components of the acquisition process is in Figure 1, adapted from Pearl (in press). This proposal specifies components both external and internal to the child during the acquisition process, and is meant to capture the iterative process of acquisition unfolding over time.

External components are observable. We can observe the input signal available to children (e.g., the child language interactions they experience). For example, consider a version of our utterance from before: *“Lisa sang to the triplets and then she took a power nap.”* The input signal is the physical signal in the world, such as auditory components like pitch, timbre, and loudness of the utterance. The input can also include other aspects of the environment, such as who said the utterance, where they said it, when they said it, and what people or objects were in the environment at the time.

We can also observe children’s behavior at any stage of development, either through naturalistic productions and behavior or clever experimental designs that elicit productions or behavior. In the example utterance above, we can observe who the child thinks *she* refers to, Lisa or the triplets. One way to do this is to present the child with two pictures, one of Lisa napping and one of the triplets napping, and ask the child to point to the picture the utterance describes.

The internal components of the acquisition process involve several pieces. The first piece concerns the information the child is able to perceive in the input signal. In particular, *perceptual encoding* involves extracting information from the input signal to create the *perceptual intake*.



This procedure reminds me of a plant trying to grow

Context: A player's first time playing Valorant

<https://youtu.be/6OEV1NwSDak?si=sp0Ga5t8AM42xDah&t=76>

Context: 3 people reacting, not involved with the gameplay directly

