Pearl 2022

Computational cognitive modeling for syntactic acquisition: Approaches that integrate information from multiple places

Section 4 intro & 4.1

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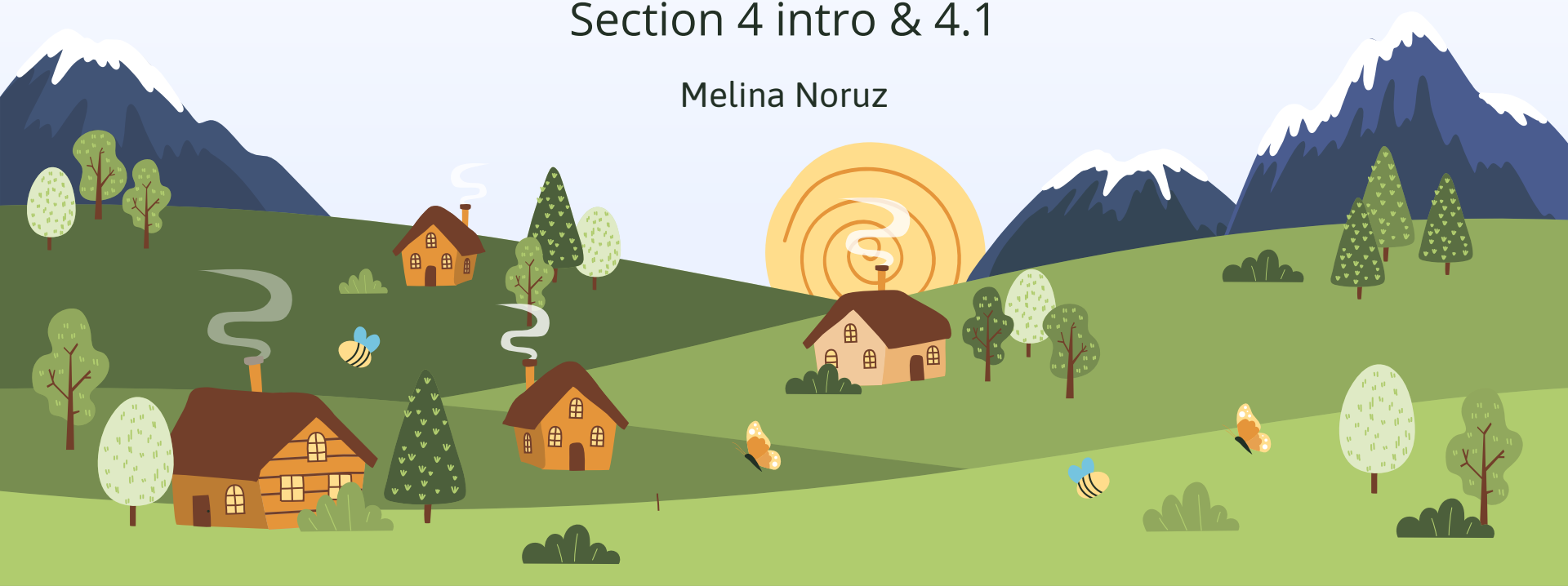


Informative models build on data collected with other techniques

Model Input
"based on estimates of the information children encounter in their language interactions."

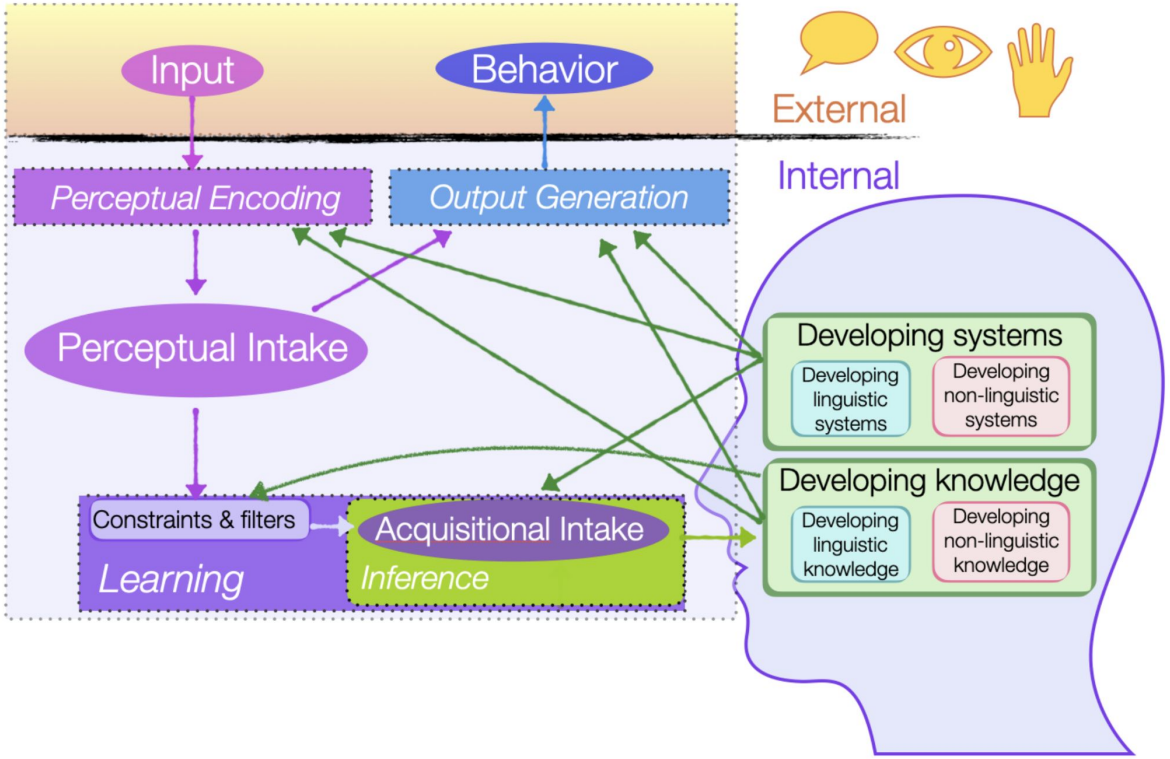
Model Learning Mechanisms
"based on ideas of what abilities and learning biases children demonstrate at certain ages."

Model Output
"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."

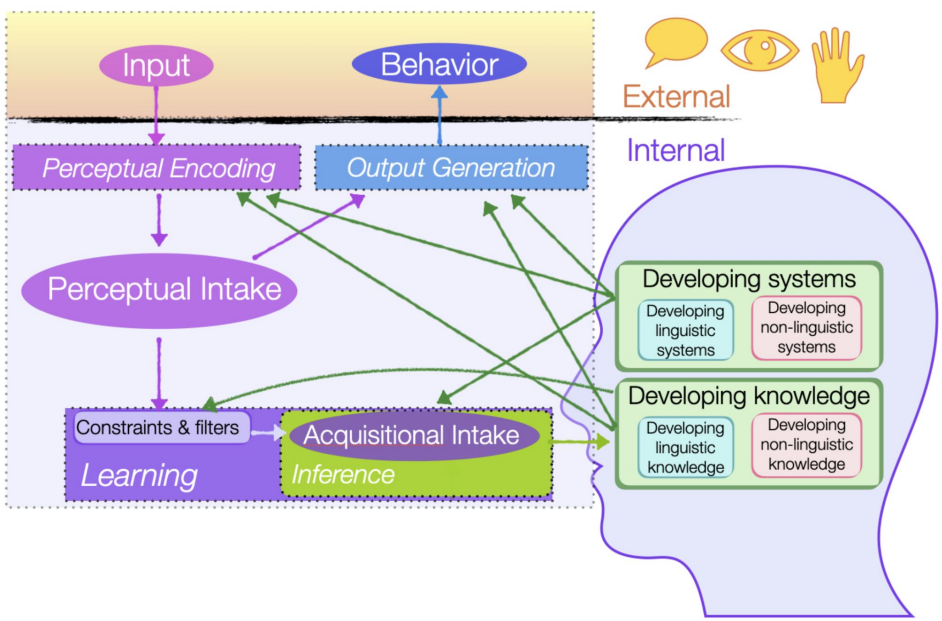
What are “better” models?

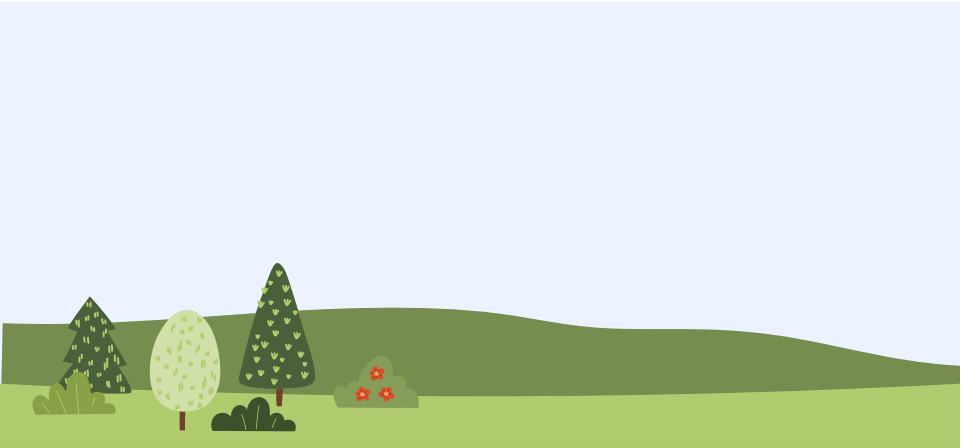
“...models that capture more of the relevant aspects of the acquisition process so that we can better link children’s input to their observable behavior. When we have these better models, we then have better explanations – as implemented in the models – for why acquisition (syntactic or otherwise) proceeds the way it does.”

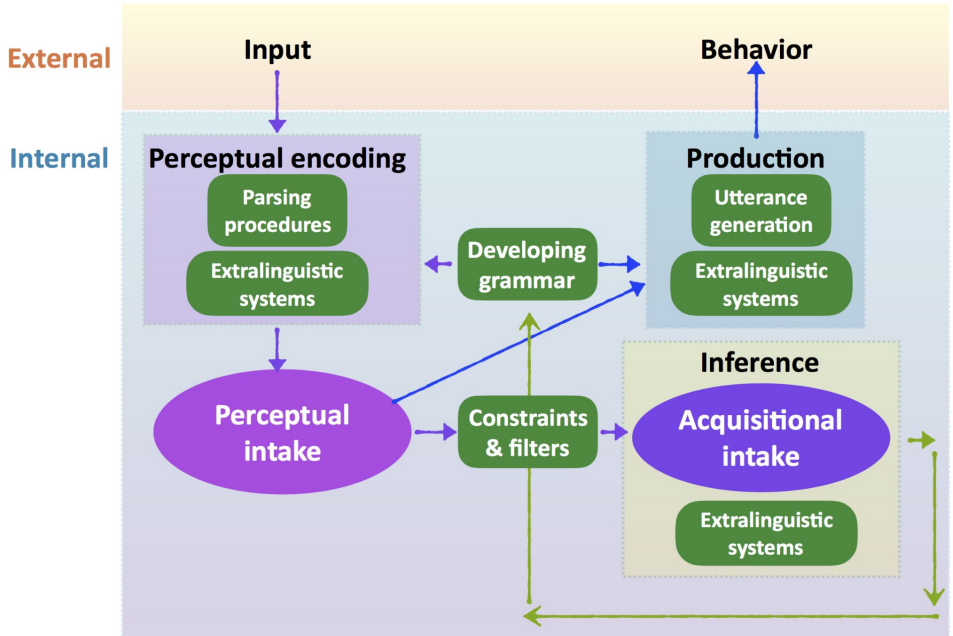
Relevant components of the acquisition process



"Internal components are not observable, and include perceptually encoding information from the input signal (yielding the perceptual intake), generating output from the encoded information (yielding observable behavior), and learning from the encoded information (using constraints & filters to yield the acquisitional intake, and doing inference over that intake). The developing systems and developing knowledge (both linguistic and non-linguistic) impact all internal components, while the learning component updates the developing knowledge."


Input
Behavior
External
Internal
Perceptual Encoding
Output Generation
Perceptual Intake
Developing systems
Developing linguistic systems
Developing non-linguistic systems
Developing knowledge
Developing linguistic knowledge
Developing non-linguistic knowledge
Constraints & filters
Acquisitional Intake
Learning
Inference




External
Internal
Input
Behavior
Perceptual encoding
Parsing procedures
Extralinguistic systems
Developing grammar
Production
Utterance generation
Extralinguistic systems
Inference
Perceptual intake
Constraints & filters
Acquisitional intake
Extralinguistic systems

External components

"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 [*'Lisa sang to the triplets and then she took a power nap.',*] 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."

Internal components

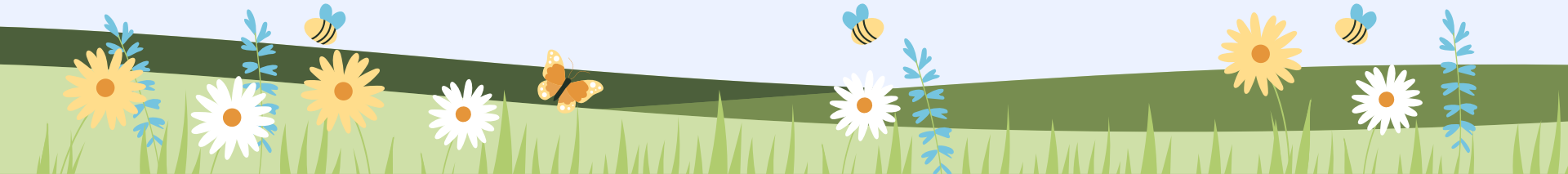
"...**perceptual encoding** involves extracting information from the input signal to create the **perceptual intake**. Perceptual encoding draws on the child's developing knowledge and systems to extract information...What children can perceive depends on what they know about their language, what they know about the world, and how well they can extract information of different kinds... extracting information from the input signal involves ignoring information present (e.g., where the utterance was spoken) and adding information not explicitly present (e.g., where the words are, how a pronoun is interpreted). What children ignore and add depends on their developing knowledge and developing systems."

Internal components

"The second internal piece concerns how children **generate their observable behavior**...children rely on the information they have been able to perceptually encode and their developing systems and knowledge...children apply their production systems to the perceptual intake in order to generate behavior like speaking (which relies on linguistic systems and non-linguistic systems involved in utterance generation). In our example utterance, a child might say "Lisa's the one napping". Children can also respond non-verbally (e.g., look at a picture that encodes a scene described by the utterance, which relies on non-linguistic systems). In our example utterance, a child might look at the picture of Lisa napping."

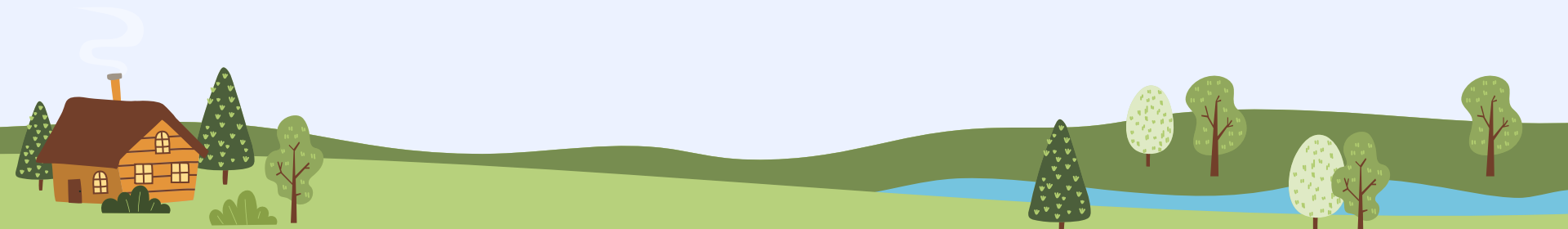
Internal components

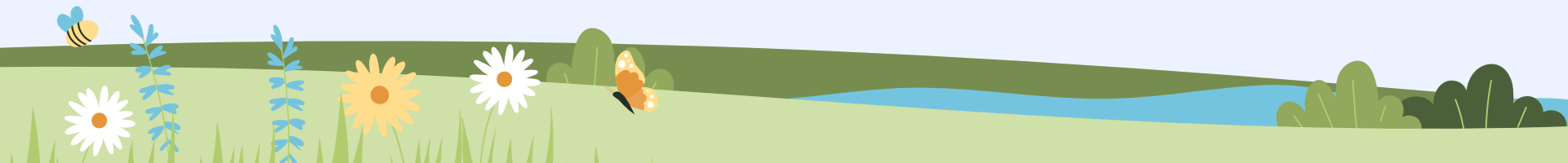
"The last internal piece concerns **learning**, which is how the child's **developing knowledge**...is updated over time...the child's developing systems and knowledge impact this piece...learning occurs over the part of the perceptual intake the child deems relevant to learn from: this is the **acquisitional intake**. The acquisitional intake is typically...not everything the child is able to encode...in our example utterance, the fact that the pronoun *she* is singular may be in the acquisitional intake, while the fact that *she* is a separate word from *took* may not."



Internal components

“The child’s developing knowledge can filter the perceptual intake down to the relevant information by providing both constraints on possible hypotheses (i.e., what options are worth considering) and attentional filters (i.e., what in the information signal to pay attention to).”



Internal components

“**Inference** then operates over the acquisitional intake, and typically involves non-linguistic abilities like probabilistic inference, statistical learning, or hypothesis testing. The result of this inference can be used to update the developing knowledge – potentially both linguistic knowledge and non-linguistic knowledge.”