

**Pearl 2023a**

***Modeling syntactic acquisition***

Section 1

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**Pearl 2023b**

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

Section 1.1-1.3

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**Pearl 2025**

***The Acquisition Process***

Section 1

**Lisa Pearl**

## Why acquisition

Pearl 2025: “Put simply, language acquisition is **something of a marvel that seems in need of explanation**. The knowledge that children develop about their native language(s) is quite sophisticated, and children develop it more completely than adults learning a new language typically can...The **cognitive capacities** (like attention, memory, executive control, and so on)...are also **limited**...Moreover, children are often **doing other things at the same time** as they’re developing their linguistic knowledge”

## Why a theory of acquisition

Pearl 2025: “So, how do we come up with an explanation? **A theory is an explanation...**how do we come up with a theory about how the process of acquisition works? If we want to build a theory, **we need to be precise about what we’re trying to explain and how we’re going to try to explain it.**”

## Why model

Pearl 2023a: “...an informative model of syntactic acquisition is the **embodiment of a specific theory about syntactic acquisition**. So, to build an informative syntactic acquisition model, you need to first have a theory about how syntactic acquisition works. Then, the model can be used to (1) **make all the components of that acquisition theory explicit**, (2) **evaluate whether it actually works**, and (3) **determine precisely what makes it work (or not work)**.”

## Why model

Pearl 2023b: “...With this tool of computational cognitive modeling, we can then make a theory about syntactic acquisition concrete enough to evaluate, because the computational cognitive model allows us to generate predictions about children’s syntactic behavior that can be evaluated. That is, when we have a computational cognitive model for syntactic acquisition, we have a theory about syntactic acquisition that is implemented precisely enough to evaluate against empirical data.”

## Making the components explicit

Pearl 2023a: “It often turns out that the acquisition theories that seem explicit to humans don’t actually specify all the details necessary to implement the strategies these theories describe.”

- example: *wh*-movement learned via triggers
  - open questions: what do children need to already know or be able to do, are there triggers for all possible options, are there default options, etc...

## Evaluating the theory and explaining what happened

Pearl 2023a: Interpreting model results: “There are two basic outcomes:

- (1) the model predictions match children’s data, or
- (2) they don’t.”

## Evaluating the theory and explaining what happened

Pearl 2023a: “If the **predictions match**, this is an existence proof that the acquisition theory, as implemented by the computational model, is ***a way that acquisition could proceed.***”

## Evaluating the theory and explaining what happened

Pearl 2023b: “That is, if the model succeeds at matching human behavior, we can only interpret this success as success of that specific implementation of that acquisition theory – we have nothing to say about other implementations of this particular theory, or other theories not implemented in the model”

## Evaluating the theory and explaining what happened

Pearl 2023a: “...sometimes the model predictions don't match children's data. What then? This is then evidence against that acquisition theory, *as implemented by the model.*”

## Evaluating the theory and explaining what happened

Pearl 2023b: “The same is true for interpreting model failure: failure is only demonstrated for that specific theory implementation.”

## Evaluating the theory and explaining what happened

Pearl 2023a: "...if you have an implemented model (whether it succeeds or fails), a very useful benefit is that you can **look inside it** to determine what exactly makes it work or not work. This is something that's much more difficult to do with children's minds. That is, **we can sift through the components of the implemented acquisition theory to see which ones are important for acquisition success**...without them, the model's predictions don't match children's behavior."

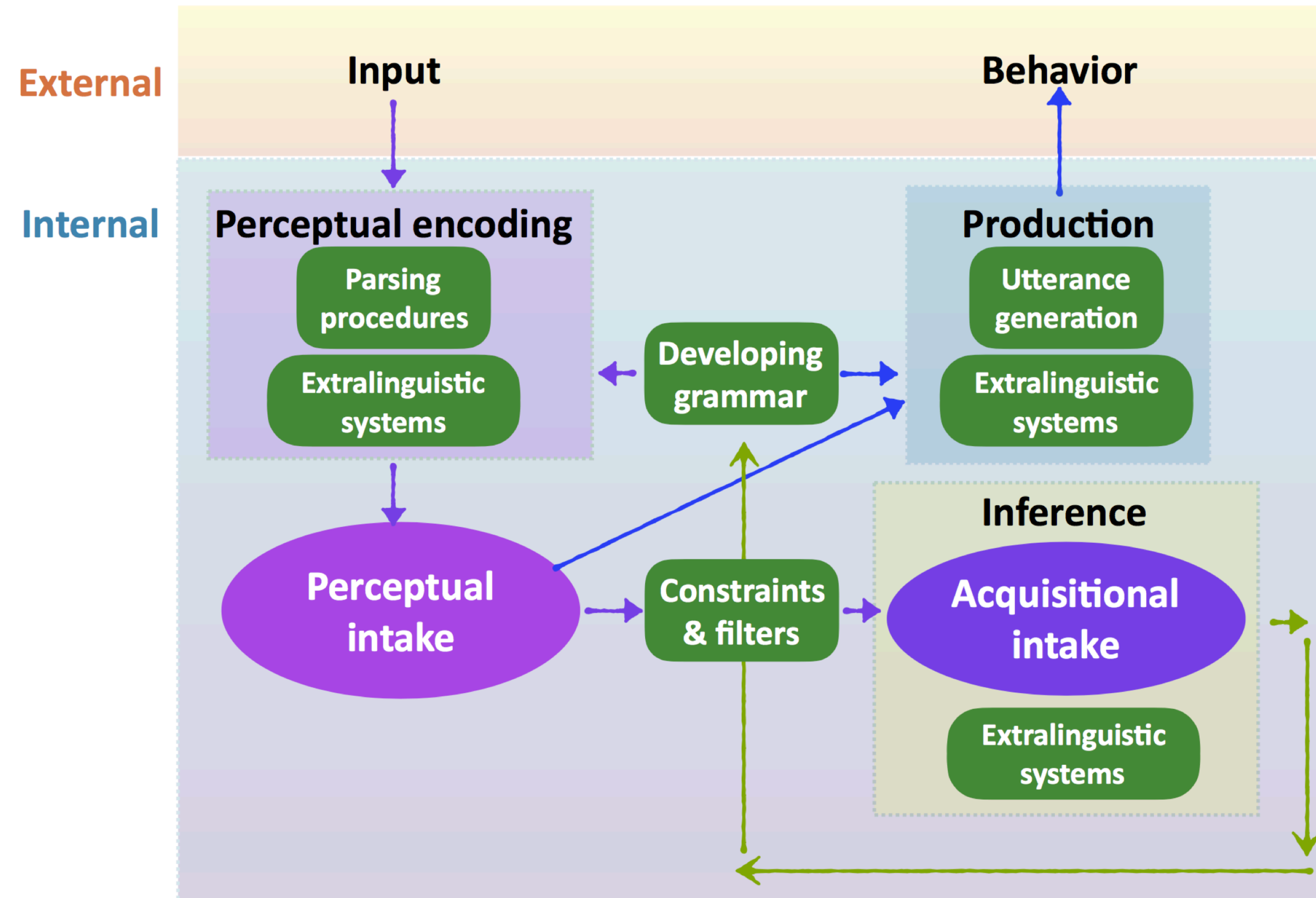
# Characterizing the acquisition task

Pearl 2023a

“Model of the acquisition process adapted from Lidz & Gagliardi (2015), highlighting the contributions of several key components.

Observable components are external to the child (input signal and the child’s behavior).

Internal components include the pieces used to perceptually encode information from the input signal (developing grammar, perceptual encoding), the pieces used to produce the observable behavior (perceptual intake, developing grammar, and production systems), and the pieces used for inference over the perceptually encoded intake (inference). These yield the next stage of the developing grammar, which itself is used in subsequent perceptual encoding and production.”



## Acquisition theorizing

Pearl 2025

“...theories help us usefully compress the data we want to explain, and one key way theories do so is by **utilizing key factors** that underlie the observable data. If we think about theories this way, one key thing we’re interested in when building a theory of the acquisition process is the **set of relevant factors for explaining the acquisition process.**”

## Characterizing the acquisition task

Pearl 2023a

Five pieces: Initial state, Data intake, Inference, Learning period, Target state

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Pearl 2023a

**Initial state:** “What knowledge, abilities, and learning biases does the modeled child **already have?**”

Pearl 2023b

“First, the model needs to **encode relevant prior knowledge and learning abilities** the child is supposed to have at this stage of development. This knowledge and these abilities are often assumed implicitly by the acquisition theory.”

## Characterizing the acquisition task

Pearl 2023a

Five pieces: Initial state, Data intake, Inference, Learning period, Target state

Pearl 2023a

Data intake: “What data is the modeled child learning from?”

Pearl 2023b

“...the model needs to learn from realistic input.”

“...encode learning...a model might attend to the distribution of certain features of the input viewed as relevant”

“...including both linguistic and non-linguistic sources of information...”

## Characterizing the acquisition task

Pearl 2023a

Five pieces: Initial state, Data intake, Inference, Learning period, Target state

Pearl 2023a

**Inference:** “How are updates to the modeled child’s internal representations made?”

Pearl 2023b

“...use probabilistic inference to group verbs together that seem similar enough with respect to those relevant features”

## Characterizing the acquisition task

Pearl 2023a

Five pieces: Initial state, Data intake, Inference, Learning period, Target state

Learning period: “How long does the modeled child have to learn?”

## Characterizing the acquisition task

Pearl 2023a

Five pieces: Initial state, Data intake, Inference, Learning period, Target state

Pearl 2023a

Target state: “What does it mean for the modeled child to succeed at learning?”

Pearl 2023b

“...the model needs to output predictions that connect in some interpretable way to children’s behavior.”

Pearl 2023a

Five pieces: Initial state, Data intake, Inference, Learning period, Target state

### Characterizing the acquisition task

“...an acquisition theory consists of specifying each component according to a theory of developing representations and a theory of developing processing abilities.”

Pearl 2023b

“...children are likely impacted by non-linguistic factors during acquisition. For instance, cognitive limitations on memory, attention, and executive control can affect how children perceive the information in their input, how they update their internal hypotheses, and how they generate their observable syntactic behavior. In addition, children likely rely on non-linguistic learning mechanisms to update their internal hypotheses, such as probabilistic inference.”