

DEVELOPMENTAL PSYCHOLOGY

What are you talking about?

Figuring out the referent of a new word is a hard problem, yet children solve it early and often. A new model by Bohn et al. proposes that young children rationally combine different sources of information when learning language. This account precisely predicts and explains novel developmental findings, above and beyond competing proposals.

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Understanding the referent of a word is a fundamental problem, nested in a collection of babushka-doll problems. The nesting is this: to become part of society (biggest doll), children need to understand the culture they're born into (big doll); to understand their culture and participate in it, children need to pick up language (smaller doll); and to figure out language, children need to map between an utterance ("smallest doll") and an object (smallest doll).

Children connect words and referents so easily that it's easy to overlook how hard this is. You might think the solution is a simple rule, such as 'when someone is pointing and saying something, they're talking about what they're pointing at'. Philosophers—never shy of pointing out that easy stuff is actually hard when you think about it—have pointed out the problems with this. Quine¹ asks us to consider a person speaking a foreign tongue saying "gavagai" as a white rabbit runs past while they are walking. Are they referring to the rabbit, or the stroll, or seeing a white streak on green? In Terry Pratchett's fantasy novels, there is a forest of Skund, where Skund means 'your finger, you fool'. As Pratchett explains, "the first explorers ... filled in the blank spaces on their maps by grabbing the nearest native, pointing at some distant landmark, speaking very clearly in a loud voice, and writing down whatever the bemused man told them. Thus were immortalised in generations of atlases such geographical oddities as Just A Mountain, I Don't Know, What? and, of course, Your Finger You Fool!"²

It's probably for the best that children don't know how hard the problem of reference is, as they seem to solve it easily, plucking thousands of new words from the air long before formal teachers get their hands on them. The problem is made easier if we as humans share expectations about communication, or biases in our attention³. If you and I both know the finger-pointing rule, or if you and I are similarly captivated

by similar objects, it's easier to figure out that by 'a babushka' you in fact mean a babushka.

All this is not new. We know the problem is hard in theory; we know children solve it in practice. Thanks to the hard work of developmental researchers, we also know some of the cues and rules that children use from early on to solve the reference problem. For example, suppose you and your friend are looking at a banana and also a fruit you're not familiar with, and your friend remarks, "oh, a shesek." Since you both already know the word for banana, it is reasonable to conclude that 'shesek' is the name of the other fruit. Even young children seem to use this rule of 'mutual exclusivity'⁴. Or suppose someone pulled a new fruit out of a bag, and your friend said, "ah, a shesek." Again, even young children expect that a new object will be the target of an unfamiliar word⁵. But what happens when these expectations conflict? What if an unknown fruit was sitting on the table in full view, then someone pulled out a banana, and your friend said 'shesek'? And how does any of this get implemented, really?

The recent work by Bohn et al.⁶ in *Nature Human Behaviour* gives a new and formally specified answer to the problem of integration of different cues. According to Bohn and colleagues' rational integration model, when hearing a familiar word and trying to determine its referent, children combine expectations about common ground, the informativeness of the speaker, and their own prior knowledge of different objects. The rational integration model nests the speaker and listener, not unlike a very small set of socially minded babushkas, with the listener thinking about the speaker thinking about the listener.

The model has three moving parts then: common ground, informativeness, and prior knowledge. In two experiments with 2–5 year old children, Bohn et al. collect novel data to estimate these parameters in isolation, using a child-friendly version of the banana–shesek situation described

above. With parameter estimates in hand, Bohn et al. use the rational integration model to precisely predict out-of-sample performance in a third experiment that combines different social cues. Importantly, Bohn et al.'s results suggest that the basic process of integration remains fundamentally the same in early development. It is only the sensitivity to the different parameters that is changing.

Bohn et al. also compare their predictions to several reasonable alternatives. First, perhaps the results could be just as well explained by a model that only pays attention to some of the social cues? A model comparison firmly suggests this 'perhaps' is a definite no. Second, perhaps children consider cues in isolation, then weigh them together, as a kind of 'bag of tricks'? This alternative is less satisfying, in that the tricks cannot be estimated from the first experiments (unlike the rational integration model), but more importantly in that the bag of tricks (and its time-varying cousin) does a worse job at explaining the overall pattern of results.

The theoretical and empirical work of Bohn et al. brings us closer to fully implementable models of reference learning, and they shed light on the early development of language learning. Still, the moving parts of the model are themselves likely not natural cognitive kinds, with parameters like common ground and informativeness soaking up a lot of different processes leading to an object being more salient or a speaker seeming more informative. It will be interesting to see what computations and variables lie nested within, once the model's parts are twisted open. □

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Competing interests

The author declares no competing interests.