One of the most astonishing features of human development is how children acquire so much knowledge within such a brief period of time. For example, at an age when they still struggle to tie their shoes, most children have already learned thousands of words. Understanding the mechanisms that drive linguistic and cognitive development is the primary goal of my research. To achieve this, I focus on an understudied issue in language development: how children learn polysemous words, or words that carry multiple, related meanings. For example, English words can label animals and meat (thirsty/tasty chicken), materials and objects (shattered/drinking glass), and more. Despite its prevalence in language—by one estimate, 84% of common English words are polysemous (Rodd, Gaskell, Marslen-Wilson, 2004)—there has been relatively little developmental research on polysemy. Considering how children learn polysemous words, I argue, can transform our understanding of the basic mechanisms that drive learning.

By most theories, it should be difficult to learn a new word when it has multiple meanings. This is because polysemous words violate a core assumption that is thought to guide learning, namely, that a single word should map onto a single category of meaning. In contrast, my research shows that children can not only learn multiple meanings for a word, but can also use their knowledge of one meaning of a word to make inferences about—and even anticipate—its other meanings. Thus, rather than impeding learning, polysemy may facilitate vocabulary development. Indeed, my research suggests that polysemy may evolve in language in response to the pressure to make language maximally learnable. Thus, polysemy may provide an example of how language—as a culturally transmitted system—has been adapted to fit how children think.

My focus on polysemy is unique, and engages several big questions in developmental science, including (1) how children learn words, (2) what language reveals about the mind, and (3) how language shapes cognition. My research also explores (4) children’s understanding of the social basis of language, from which I have developed a secondary line of work on social cognitive development, focused on (5) how children reason about social norms and groups cross-culturally. Below, I review my research in each of these five areas, as well as some future directions for each area. To address these topics, I conduct behavioral experiments with children internationally. My research also incorporates computational analyses of language corpora.

1. What polysemy reveals about how children learn new word meanings

Discerning a new word’s meaning is a daunting task, since words are typically uttered in complex scenes in which they could have many interpretations (Quine, 1960). For this reason, it is widely agreed that successful word learning can only take place because children make assumptions about what words will mean. For example, children might assume that a new word will have a single meaning, and apply to items of the same taxonomic kind (Markman & Hutchinson, 1984). Curiously, although this heuristic is thought to support learning, most words are polysemous and express multiple, taxonomically different meanings, violating this heuristic (e.g., chicken labels an animal and meat). I study the acquisition of polysemous words as a test of the mechanisms that drive word learning. The basic logic is that if children are guided by a one word = one category heuristic, they should be confused by polysemy. But if children do not have difficulty with these words, they may make entirely different assumptions about word meaning.

1.1. Early representations of polysemous words. How might a child who believes that each word will map onto a single taxonomic category learn polysemous words? One possibility is that initially, children mistakenly learn the different uses of a polysemous word like chicken as
unrelated words that each label a single category, similar to homophones like *bat* (baseball vs. animal). Or, children might learn a single, overly broad meaning that fails to distinguish the different uses of a polysemous word, e.g., lumping *chicken* animals and *chicken* meat together.

Across several papers, I find that preschoolers do not make these mistakes. For example, when taught that a novel “muppet” word labels one meaning of a known polysemous word (e.g., *blicket* labels chicken animals), children spontaneously expect the muppet word to also carry another meaning of the polysemous word (chicken meat), but do not do the same for homophones like *bat*. Thus, while children represent homophones as unrelated words, they treat the different uses of polysemous words as related meanings of a single word (Srinivasan & Snedeker, 2011, 2014). Further, children understand that the different uses of polysemous words are distinct. Preschoolers rarely extend properties between items corresponding to different meanings of a polysemous word—e.g., between a *chicken* animal and *chicken* meat—suggesting that they do not lump them into a single, broad category (Rabagliati & Srinivasan, in prep).

1.2. Learning advantages of polysemy. The research above suggests that polysemy does not confuse children, but could it instead facilitate word learning? Polysemy could aid learning by allowing children to use one word meaning to guess the structure of another word meaning. Imagine a child who has learned that *tin* refers to a material, and who then observes an object made of that material called *a tin*. They could guess that the object meaning of *tin* will be defined in part by the material. In our studies, preschoolers are taught a name for a novel material and a name for an object made from the material, and we vary whether the material and object receive the same polysemous label or different labels (Srinivasan, Berner & Rabagliati, in press). We find that children who receive different labels for the material and object typically extend the object label to other objects matching in shape (Landau, Smith & Jones, 1988), while children who are taught a polysemous label extend the object label based on material. This suggests that children’s knowledge of one meaning of a word can affect their construal of another meaning for that word.

I also find that polysemy allows children to anticipate new word meanings. For example, after learning that *daxing* labels an action involving a novel tool, preschoolers spontaneously expect the tool itself to be called *a dax*, similar to how polysemous words like *shovel* and *rake* are used (Srinivasan, Al-Mughairy, Foushee & Barner, 2017; Skarabela, Rabagliati & Srinivasan, in prep). Thus, even before children observe the different ways in which a new word can be used, they can infer its possible meanings, generalizing from their knowledge of systematic polysemy. Given how common polysemy is, the ability to use one word meaning to infer its other meanings could be a powerful tool for building a lexicon (Rabagliati & Srinivasan, in press; Srinivasan, 2016; Srinivasan & Rabagliati, 2015). My future work will explore whether polysemy not only scaffolds children’s acquisition of new word meanings but also their memory for these meanings.

1.3. Developmental origins of polysemy. My planned and future research explores how children’s understanding of polysemy develops from early in life. Are children initially guided by a one word = one category assumption that they later abandon to accommodate polysemy? Or can even infants learn multiple distinct and related meanings for a word? Also, how does children’s ability to anticipate new meanings of a word develop? I will address these questions via experiments with infants and toddlers, and analyses of how children are exposed to polysemy in their language environments, using child language corpora.
2. What polysemy reveals about cognition

The idea that polysemy aids word learning could help explain why it exists. The pressure to make language learnable—so that it can be transmitted across generations—may lead meanings to be packed into words in ways that facilitate learning. Polysemy may be widespread because it is easier to learn a lexicon in which each word has multiple, related meanings, compared to one in which each word is unambiguous. My research suggests that words have developed new meanings over history and across languages in ways that are adapted to cognition.

2.1. Cross-linguistic variation in polysemy. If polysemy has been shaped by learning pressures, then instances of polysemy that recur across languages should reflect conceptual relations that are easy to understand, explaining why such polysemy is integrated into many languages. Instances of polysemy that rarely appear, by contrast, should be more difficult to learn. My research demonstrates that most English patterns of polysemy are also present in other languages (Srinivasan & Rabagliati, 2015). However, one pattern of English polysemy that is rare in other languages—using words to label substances (some milk) and the removal of those substances (milk the cow)—is also difficult for English learners to understand (Srinivasan & Barner, 2013). Preschoolers mistakenly assume that these verbs denote transfer to goal locations, such that milking the cow means “putting milk onto the cow.” Our newest work tests the relation between polysemy and cognition using data from 247 different languages (Xu, Duong, Malt, Jiang & Srinivasan, under review). We find that concepts that are more strongly associated are also more likely to share a label across languages. Our future research will test whether it is easier to learn new polysemous words for concepts that are more often lumped together in other languages.

2.2. Historical evolution of polysemy. Drawing on large-scale English corpora dating back a millennium, our team has used computational models to show that words have developed new meanings in predictable ways. This research has received media coverage. In one study, we compare different algorithms of how new word meanings might “attach” to existing meanings of a word (Ramiro, Srinivasan, Malt & Xu, 2018). We find that an algorithm that would minimize the costs associated with communicating and learning new word meanings—by ensuring that new word meanings develop from existing meanings that are most semantically related—is best able to predict the actual historical order in which a word’s different meanings have emerged.

In another study, we have provided the first large-scale evidence that concrete words (e.g., grasping an object) have been metaphorically extended to label abstract concepts (grasping an idea) more often than the reverse (Xu, Malt & Srinivasan, 2017; Winter & Srinivasan, in prep). Scholars have long asked why this asymmetry exists (Lakoff & Johnson, 1980). My research suggests that such metaphors might be widespread because they help children learn words for abstract concepts. We find that it is easier for children to learn novel words with concrete meanings (daxy = high in space) and then extend them to more abstract meanings (daxy = high in pitch), than to directly learn words for the abstract meanings (Starr & Srinivasan, in prep).

3. The effect of polysemy on cognitive development

According to some theories, language not only reveals—but also shapes—how we think (Whorf, 1956). My work provides evidence that polysemy both builds on and influences children’s conceptual development. I also show that speakers of different languages may think differently about the world, due to differences in the languages they have learned.
3.1. Using polysemy to learn about the world. Current theories propose that children expect items sharing a label to belong to the same category, even when they are dissimilar (Waxman & Markow, 1995). My research shows that children do not follow this assumption blindly, as they do not conflate the different referents of a polysemous word—e.g., chicken animals and chicken meat—into a single category (Rabagliati & Srinivasan, in prep). However, learning that the same word labels different concepts could invite children to learn how those concepts are related. As noted above, we find that children use information from polysemy to make inferences about new categories: if children learn that a word that labels a material (some dax) also labels an object (a dax), they expect the object kind to be defined by material, rather than shape (Srinivasan, Berner & Rabagliati, in press). Future research will explore whether polysemy frames how children explore and learn about new concepts. For example, we test whether learning that a word for an object (a dax) also labels a use of that object (it is daxing) leads children to think that the object has been designed for that function (daxes are for daxing), and may not support other functions.

3.2. Polysemy and cross-domain associations. Does learning polysemous words lead children to create new associations between concepts? My research focuses on cases in which spatial words are also used to describe time (long, short) or pitch (high, low). I find that learning these words does not lead children to construct new cross-domain associations: Even 9-month-olds, who have not learned words like long or short see similarities between “long” lines and “long” sounds (Srinivasan & Carey, 2010). Further, English-learning children can map stimuli across domains, not only when mappings are expressed in English polysemy (e.g., “high” and “low” in space and pitch), but also when they are unfamiliar in English (e.g., Farsi words for “thick” and “thin” apply to both space and pitch; Starr & Srinivasan, in press). These findings suggest that some polysemous words reflect pre-existing structural parallels between concepts and do not lead children to create new mappings. In other work, we have characterized the link between space and time by showing how children use space—in their spontaneous gesture—when talking about time (Marghetis, Tillman & Srinivasan, in prep; Tillman, Marghetis, Barner & Srinivasan, 2017). We are now using eye-tracking to understand how cross-domain mappings arise over development, and whether linguistic experience influences the automaticity of these mappings.

3.3. Linguistic relativity. The relationship between language and thought can be studied not just in development, but also by exploring whether speakers of different languages think differently. For example, unlike English, where count nouns can be pluralized, Mandarin Chinese requires the use of measure phrases to quantify objects (“I have two long-thing of snake”). These measure phrases are used flexibly, to classify different objects, e.g., the same measure phrase applies to snakes, scarves, and pants. Consistent with the idea that learning measure phrases affects quantification, I find that Mandarin speakers have difficulty counting a target object (like snakes) when they have to ignore distractor objects that share the same measure phrase (like scarves; Srinivasan, 2010). I have recently published theoretical pieces on the relationship between mass-count syntax and quantification (Srinivasan & Barner, 2016; Srinivasan & Barner, in press).

4. Children’s understanding of the social basis of language

Above, I have discussed cognitive constraints on language, but language also relies on our ability to reason about our interlocutor’s intentions and the social conventions of language. Thus, if an English speaker asks for “a blicket,” we assume that she doesn’t want a cup, because otherwise she would have used the conventional word “cup”. We thus infer that “blicket” must refer to
another object, an inference called mutual exclusivity (Markman & Wachtel, 1988). My research elucidates the role of socio-pragmatic reasoning in children’s interpretation and use of language.

4.1. Mutual exclusivity and linguistic conventionality. By some accounts, mutual exclusivity requires reasoning about others’ mental states. For example, a child could assume that their interlocutor knows the English word “cup” and thus infer that it would be uncooperative of them to ask for a cup using “blicket.” Based on this logic, researchers have used mutual exclusivity to index whether children expect others to share their knowledge of alternative words (like “cup”), and have concluded that children expect common nouns to be known by other speakers of their language (Diesendruck & Markson, 2001). My studies challenge this conclusion by showing that children make mutual exclusivity inferences even when they deny that an interlocutor shares their knowledge of an alternative word (Srinivasan, Foushee, Bartnof & Barner, under review). This suggests that mutual exclusivity inferences are based on children’s own knowledge of words, and their belief that each object will have a single label in their language. This addresses a debate on the role of mental state reasoning in word learning, and opens new questions into how children guess whether others share their knowledge, which I will address in future studies.

4.2. Pragmatic inference and word meaning. Before age 7, children make a puzzling failure when interpreting words: When asked to “count the shoes” and shown two whole shoes and a third cut into two parts, children count each part as a “shoe,” resulting in a count of four shoes (Shipley & Shepperson, 1990). My work suggests that children count parts as wholes because they fail to make a pragmatic inference: If the experimenter had wanted shoe parts to be counted, she would have said to count “pieces of shoe” (Srinivasan, Chestnut, Li & Barner, 2013). This research suggests that we decide what a word refers to in part by contrasting it with alternative utterances. New research in my lab asks whether children form stereotypes via pragmatic inference. We ask whether children use a statement about one group to update their beliefs about an unnamed group: does “boys are good at math” lead children to infer that girls are bad at math?

4.3. Children’s understanding of linguistic subjectivity. Evaluating the truth of an utterance can require considering an interlocutor’s beliefs. For example, speakers can disagree about whether a building is pretty or boring, or whether it is tall or big, without either being wrong, because the meanings of these words depend in part on their speaker’s perspective. In contrast, if speakers disagree about whether a building is striped or spotted, one speaker must be at fault. We find that even 7-year-olds struggle to permit disagreement for adjectives like pretty and tall, and state that speakers who side with their own perceptions are “correct” (Foushee & Srinivasan, in prep). Future studies will explore how children construct an understanding of linguistic subjectivity.

5. Children’s understanding of social groups and norms

My research on children’s understanding of conventions in language has led to a broader interest in how children reason about norms for how to act, and the groups they apply to. Recognizing the need to expand research beyond Western convenience samples, much of this work has been conducted in India, where I have focused on local dynamics involving religion and caste.

5.1. Reasoning about social norms. Recently, I have explored how Hindu and Muslim children in India reason about norms that differ between their respective religions. This is an issue of societal importance because Hindu-Muslim conflict in India often centers around differences in religious rules, such as whether it’s okay to eat beef. Our studies—conducted with children from a region with a history of sectarian violence—find that children are surprisingly tolerant of one
another’s religious practices (Srinivasan, Kaplan & Dahl, in press). In particular, children restrict
the norms of their own religion to followers of their religion, and expect members of the other
religious group to follow their own customs, providing hope that ongoing religious conflicts may
subside over time. Further, children draw a distinction between religious and moral norms, by
judging that God can change religious rules but cannot make it permissible to harm others. This
research has been covered by media outlets, both in the United States and in India. Our newest
research explores how children understand each other’s religions (Shtulman, Foushee, Barner,
Dunham & Srinivasan, under review) and reason about the contexts in which religious norm
violations occur (Dahl, Berner & Srinivasan, in prep), with future work planned in India, Israel,
and the US.

I have also conducted research on how preschoolers differentiate between kinds of social norms.
Transgressions that violate social conventions, like dressing inappropriately at school, can be
thought of as being extrinsically wrong, because they violate an explicit rule. But transgressions
of moral norms, like hitting someone, are intrinsically wrong because they result in harm to
victims (Turiel, 1983). I find that preschoolers rapidly make this distinction when observing
novel transgressions, on the basis of a small set of social signals (Srinivasan & Dahl, in prep).

5.2. Attitudes toward social groups. There has been a rise in Hindu-Muslim conflict in India
recently, coinciding with a political movement that identifies India as a Hindu nation. My
research explores how exposure to communal conflict and nationalist rhetoric might affect Hindu
and Muslim children’s intergroup attitudes and social identity. Through extensive studies in
India, I hope to derive broader lessons for understanding the challenges faced by children in
comparable contexts across the world (see also Srinivasan, Dunham, Hicks & Barner, 2015).

Our research indicates that from at least the third grade, Hindu and Muslim children each show
explicit and implicit biases against each other’s respective religious groups (Dunham, Srinivasan,
Dotsch & Barner, 2014). Additionally, we find that Hindu—but not Muslim—children conflate
being Indian with being Hindu (Ellwood-Lowe, Berner, Dunham & Srinivasan, in prep). This
Indian = Hindu bias is also linked to children’s support—or lack thereof—for social policies
related to religious tolerance and affirmative action. Our ongoing longitudinal work traces the
development of these attitudes and their relation to children’s friendship networks at school
(Dunham & Srinivasan, in prep). We find that the degree to which a child is segregated within a
social network predicts the extent of their intergroup bias: e.g., Hindu children who are more
segregated from Muslim children are more likely to endorse antisocial attitudes toward Muslims.
Our future work will leverage social network data to target interventions toward the most popular
students in a school, to achieve changes in school norms around intergroup interaction.

6. Summary and Future Directions

My research program has already made significant contributions to developmental science. For
example, my work suggests that theories of word learning that focus only on how children learn
words with a single meaning are fundamentally incomplete. By acknowledging the true
flexibility of word meaning, my studies uncover how development can build on itself, as children
leverage their knowledge of prior meanings of a word to learn its other meanings. Further, my
research suggests that, rather than being an impediment to learning, polysemy may be an
adaptation to the pressure to make language learnable, and may both reveal and shape how we
think. My work has also generated new insights regarding the role of socio-pragmatic reasoning in language development and children’s developing understanding of social norms.

Above, I have described ongoing and future directions that will broaden my research program and deepen our understanding of human development. Recently, my students and I have also begun a new line of work, motivated by the reality that development can take place within dramatically different environments, both economically and culturally. This research seeks to understand how children’s early language environments affect their linguistic and cognitive development. Using a combination of experimental and observational methods, we are asking why parents from lower socioeconomic (SES) backgrounds direct less speech to their children than high-SES parents, as well as whether children who receive less directed speech can adapt their learning strategies to attend to interactions around them, and learn from overheard speech (Foushee, Srinivasan & Xu, in prep). This research could inform interventions to ensure that all children receive rich, directed speech, and provide insight into individual differences in how children learn.

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