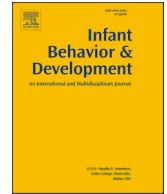




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Accent variation and the development of speech and language abilities

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ABSTRACT

Accent variation is a central feature of human language. As adults, we readily adapt to different varieties of our native language, but we also use accent information to make a variety of social inferences. Thus, our treatment of accents sits squarely at the intersection of language and social processing. Despite the ubiquity of accent variation and its importance in our mental lives, it was long absent from studies in the field of infant development. Although the complexities of bilingual input were recognized, the study of monolingual language development proceeded as if all infants were exposed to a single variety of their native language. This perspective shaped our theories of speech and language development. The first study to explore infants' perception of accents was published in 2000. Over the past 25 years, there has been a steady increase in work on infants' treatment of new accent varieties, their handling of multiple varieties in their natural input, and their accent-based social inferences. There is much left to be learned about just how infants navigate the rich tapestry of speech variation in their environments, but this work has already provided an important window into the nature of infants' speech representations and has upended our understanding of how early links between language and social variation are formed. We conclude our review by highlighting how understanding infants' treatment of accent variation is critical for developing models that can account for efficient speech and language development in linguistically diverse contexts.

1. Accent variation and the development of speech and language abilities

The field of infant speech perception was born in the last quarter of the 20th century. Early work revolutionized how we view development, showing just how much infants know about their language before they speak their first words. But, as much as we have learned over the past 50 years, our knowledge is still shockingly incomplete. The vast majority of infant speech work carried out in the 20th century focused on monolingual English-learning infants, largely from upper-middle to high SES families. Course correction in the 21st century involved a growing focus on a broader swath of learners - infants learning languages other than English, bilingual infants, and infants from more diverse SES backgrounds. This more inclusive approach to studying infant speech development has been hugely important for advancing our understanding of early development. But there is an additional key, under-studied, dimension of experiential variation that cuts across monolingual and bilingual populations from every SES class – accent variation. As the first quarter of

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the 21st century comes to a close, the field has fully accepted that we must better understand the diversity of language learning environments that infants are equipped to navigate – crucially, this includes accent variation. Here, we discuss the emergence of work on accents in the last 25 years, and sketch out how continued advancements in this area will lead to the development of more experientially grounded and generalizable models of infant speech development.

2. The learner's input is important – but are we fully capturing the input?

As in most areas of developmental psychology, the biggest issue in the field of language acquisition has been understanding how children's inborn constraints and environmental input contribute to their language knowledge and outcomes. From diary studies (Leopold, 1949) to modern day audiovisual recordings (Hart & Risley, 1995; Roy et al., 2015), the field has seen an explosion in efforts to document the properties of children's input. This work has demonstrated that children's language environments differ in myriad ways and that these differences are related to children's language outcomes: in the clarity of the speech sounds they hear (Cristia, 2011; Liu et al., 2003), in the number of words spoken around them and to them (Hart & Risley, 1995; Sperry et al., 2019), in the diversity of words (Hart & Risley, 1995) and their referential clarity (Cartmill et al., 2013), in the number of conversational turns (Ramírez-Esparza et al., 2014; Romeo et al., 2018), and in the complexity of their grammatical structures (Huttenlocher et al., 2007). Importantly, the field has also moved past the assumption that a single talker (i.e., the mother) provides all of an infant's input. Cross-linguistic corpus studies demonstrate that infants are learning language from multiple possible sources – male figures, extended family, and other children (Loukatou et al., 2022; Pancsofar, Vernon-Feagans, 2006; Soderstrom et al., 2018; Shneidman & Goldin-Meadow, 2012). Already, observations about the variability of infants' language environments are changing our understanding of how early language development works (Casillas et al., 2020; Cristia et al., 2019; Foushee & Srinivasan, 2024).

However, even now, analyses of input routinely fail to account for the potential presence of accent variation. Instead, even our most state-of-the-art examinations of infants' input focus on variation along dimensions such as the number of speakers (of different genders) (Bergelson et al., 2019; Bergelson et al., 2024; Bulgarelli et al., 2021), with no information provided about the language varieties spoken by different talkers in a child's environment. The failure to consider that learners might be exposed to multiple accents of their native language(s) – and lack of widespread discussion of how this impacts speech development – is problematic for at least two important reasons. First, on a practical level, given the demographic makeup of most families and societies, a sizable percentage of infant learners are exposed to multiple accents in their home and community environments. This is particularly true for children learning more than one language (especially if their primary caregivers do not share a common L1). Thus, a focus on only a single accent misrepresents the language learning problem facing the majority of children, especially the multilingual children researchers have been studying more intensely in recent years. Second, on a more theoretical level, our focus on a single accent has led to the development of theories designed to handle mono-accent input. In this review, we argue that the study of how infants handle accent variation is critical not just for achieving greater ecological validity in the field, but also for ensuring that our theories can explain language learning in the real world.

3. Attunement to the native language shapes perception – but do we know what the native language is?

Decades of work have demonstrated that tuning to the native language occurs from the very earliest moments of development – by birth, infants are sensitive to the rhythm and melody of the language they were exposed to in utero (Byers-Heinlein et al., 2010; Mamepe et al., 2009; Mehler et al., 1988), and over the course of the first year, their processing of individual speech sounds and the sound patterns of words is shaped by the properties of the native language (Anderson et al., 2003; Jusczyk et al., 1993; 1994; Kuhl et al., 1992; Polka, Werker, 1994; Werker & Tees, 1984). Infants even show comprehension of some frequent words as early as 6 months (Bergelson & Swingle, 2012; Tincoff & Jusczyk, 1999).

But, just as the presence of accent variation has been largely ignored in our explorations of the input learners receive, so, too, has it been ignored in our studies of early speech perception. Almost all of what we have learned about infant speech perception is through studies that have presented infants with only a single, "standard" accent. But is presenting a child with any variety of their native language the same as presenting them with their own variety? Historically, the field certainly seemed to (at least implicitly) assume so. Indeed, the first experimental study on infants' processing of accents in 2000 was a control study requested by reviewers for a longer study on language discrimination (Nazzi et al., 2000). In the original drafting of their work, the authors had assumed American English learning 5 month olds would treat British as their native language; indeed, there may have been an implicit assumption that American infants could not even tell apart American and British English. But surprisingly, though American infants seemed to treat British English as more familiar than other rhythmically similar languages like Dutch and German, they also clearly distinguished between British and American English. This impressively sophisticated perception of different varieties of the native language by 5 months old suggested we had a lot to learn about early sensitivity to accent variation.

From this beginning, it still took 9 more years for the field to begin the study of accent processing in earnest. In 2009, a study examined whether toddlers could recognize familiar words spoken in an unfamiliar accent (Best et al., 2009) – the answer was no. That same year, another study found that infants under 13 months of age struggled to recognize familiarized word forms presented in a new accent (Schmale & Seidl, 2009; see also, Schmale et al., 2010). These studies had important implications for the field. If toddlers struggled so much to recognize or understand familiar words in unfamiliar accents, then what did this mean if they were encountering different accents in their environments? In the past decade, the field has begun to recognize the importance of studying infants' treatment of accent variation and the insights that can be gleaned from it. In our opinion, this work may do more than just provide insights – it may lead to the overturning of longstanding assumptions in the field.

4. What have we learned so far from the study of accent variation?

There are three broad areas in which this nascent body of research has begun to alter our understanding of early development. The first asks when infants demonstrate sensitivity to accent differences. The second involves learners' ability to map between known and novel accent varieties. That is, given a language learner whose system has been tuning to a specific variety of the language, what happens when they hear speech that does not match this system? And the third involves the situation of the (many) infants who are exposed to multiple accents in their daily lives. How does hearing more than one accent influence the development of speech and word representations? Below, we briefly summarize research from each of these areas.

4.1. Sensitivity to accent differences

As mentioned above, the first study on accent perception in infancy asked whether 5 month olds could tell apart British and American English (Nazzi et al., 2000). Infants' success in this task was surprising, in part because most work at the time suggested infants were relying solely on rhythmic differences to distinguish different languages, and these two varieties of English were from the same rhythm class. But perhaps an even bigger reason infants' success was a surprise was because it suggested we had overlooked an important variable in speech and language development. Indeed, our corpus-based computational work at that point in time typically converted audio recordings to transcripts containing idealized pronunciations of words in a single language variety – perhaps because we assumed young infants were not sensitive to accent differences. Subsequent work replicated the initial finding of Nazzi et al. (2000), showing that both British and Australian 5 to 6 month olds could tell apart different varieties of English (Butler et al., 2011; Kitamura et al., 2013). Interestingly, this work suggested that infants could only tell apart different varieties of their native language if one of the two varieties was the infant's own (Butler et al., 2011). It also suggested that infants may begin to ignore accent variation in some contexts as they grow older (Kitamura et al., 2013; Phan & Houston, 2008), when they realize that different varieties of their native language are all part of the same language (Kitamura et al., 2013). But even if infants shift their attention to accent variation over the course of development, studies with older children suggest that the general ability to tell apart language varieties improves as children mature (e.g., Jones et al., 2017). The most recent work looking at how infants tell apart language varieties has demonstrated that this ability seems to rely on activity in the left hemisphere, suggesting that telling apart accents draws upon language-specific resources rather than general acoustic sensitivities (Cristia et al., 2014). Moving forward, the field will need to look more closely at infants' ability to tell apart L1 and L2 varieties of language – if infants in some cases struggle to distinguish between accent differences, this could have substantial impact on the types of statistical regularities they draw from their input (Paquette-Smith & Johnson, 2015).

4.2. Recognizing words in unfamiliar accents

Of course, simply telling apart accents does not indicate how infants process other-accented speech. How well do infants cope with accent variation when processing spoken language, particularly when it comes to recognizing familiar words spoken in unfamiliar accents? Consider an infant learning Canadian English, in which the word “shark” is pronounced [ʃɑ:k]. Even in the first year of life, infants' recognition of that word will be disrupted if it is mispronounced by a small degree (i.e., even in the pronunciation of a single sound). This early tuning to the native language sound structure is thought to be critical for word learning (Kuhl et al., 2008). Yet, that same difference (and many other differences of that magnitude) exists in the pronunciation of words *across* accents, such as between Canadian and Australian English (e.g., the word “shark” in Australian English would be pronounced as [ʃɑ:k]). Thus, if infants are too rigid in their processing, tuning to the specifics of a particular variety should make the processing of other varieties extremely challenging. And, given the large body of evidence demonstrating that learners have a bias to map novel pronunciations of words to new meanings (Lewis et al., 2020), an inability to adapt to novel pronunciations would predict a considerable delay in vocabulary development.

The majority of developmental work on accent variation has tackled this question, by introducing learners to new accents in the lab, to see whether/when they are able to recognize words in these new accents (and what type of information they might use to do so). Initial studies suggested that infants and toddlers had considerable difficulty processing speech in unfamiliar accents (Best et al., 2009; Mulak et al., 2013; Schmale et al., 2009; 2010). For example, although infants had been shown to prefer listening to familiar over unfamiliar words in their language by 11 months (Halle, deBoysson-Bardies, 1994), they did not show this listening preference when the words were produced in a novel accent (Best et al., 2009). Subsequent work, however, has found that, at least under some circumstances, even 15-month-olds can adapt to new accents in the lab (van Heugten & Johnson, 2014) and by 24 months, toddlers may even be able to understand words in a new accent without prior exposure (at least with visual support; Johnson et al., 2022). This means that, rather than demonstrating a rigid bias to map new wordforms to new meanings, even young learners can rapidly adapt to the new pronunciations.

While it is important in any area of development to ask *when* children succeed at particular tasks, it is even more important to determine *how* they are succeeding. In the first study to ask how young learners might adapt to novel accents, White & Aslin (2011) tested 19 month olds' recognition of words produced in a novel, vowel-shifting accent (where words with the vowel [a] were pronounced with an [ae] instead). Critically, though, they provided a preceding familiarization phase, in which toddlers were presented with words in the new accent in the presence of visual referents. Following this familiarization, toddlers were not only able to recognize the familiarized words, but also other words that had not been previously heard in that accent. These results suggested that toddlers were using knowledge of the intended words (via the pictured referents) to adapt to the novel pronunciations.

Thus, knowledge of a speaker's intended production can facilitate the adaptation to new accents. But there is a further question

about how adaptation happens – what is the nature of the adjustment process? One possibility is that children are learning the specific mapping between the new system and their own. For example, a Canadian English-learning infant hearing Australian English may determine that ‘r’ sounds present in their accent are deleted in the corresponding Australian versions. If children are indeed learning a specific mapping, then following exposure to a particular accent, we should see recognition of only those forms that fit that mapping, rather than a general tolerance for pronunciation changes. In keeping with this prediction, toddlers in [White & Aslin \(2011\)](#) did not show recognition at test for words produced with a different (untrained) vowel shift. This suggests that toddlers had engaged in a targeted re-mapping of the [a]-[ae] vowel shift, not a general loosening of their criteria for recognition.

However, there is also evidence for an alternative means of adaptation. For example, 24-month-old English-learning infants exposed to Spanish-accented speech later recognized novel words in that accent, even without hearing the specific changes involved in those words before ([Schmale et al., 2012](#)). In this context, it does not seem that infants were learning specific mappings between the accents. Rather, the presence of unexpected variation might have led the speech processing system to either expand speech category boundaries or to relax the decision criteria for determining word identity (see [Potter & Saffran, 2017](#); [Schmale et al., 2015](#)). At first glance, these studies appear to be at odds – are infants learning specific mappings or just engaging in a general expansion process? In our view, this difference is not a contradiction, but an indication that even young learners have multiple routes available to them to handle accent variation. One likely possibility is that the use of one route over another is a result of the complexity of the difference between the novel accent variety and the learner’s own ([Cooper et al., 2022](#)). Delineating the conditions under which each strategy is used will reveal a great deal about the early speech processing system and how it flexibly meets the demands of different speech environments.

4.3. Growing up with multiple varieties

Studies where novel accent varieties are introduced in the lab have provided insight into infants’ and toddlers’ abilities to update their processing in response to new input. But hearing simple words or sentences from a disembodied voice does not represent what learners deal with in the real world. Moreover, many learners are growing up with multiple varieties in their input, and not being exposed to new accents for the first time in the lab. Therefore, to really understand how accent variation affects language acquisition, we must take advantage of differences in natural exposure in the wild. An emerging area of study looks at how exposure to accent variation in the real world affects language development and speech processing. Just as we might ask about the nature of the representations that support dual language knowledge in bilingual learners, so too, can we ask about the nature of speech and word representations in learners exposed to two varieties of their native language. For example, does exposure to multiple varieties affect perceptual narrowing, lexical development, and word recognition? Although we cannot answer these questions yet, the little work that has been done so far reveals a number of interesting patterns. Some work suggests that infants prioritize one variant over others in their input ([Floccia et al., 2012](#)), whereas other work suggests that they maintain separate representations of their two variants, and can deploy them as needed ([van der Feest & Johnson, 2016](#)). It has also been suggested that, in some contexts, multi-accent infants may be slower to recognize words spoken in the locally dominant variety ([Buckler et al., 2017](#); [van Heugten & Johnson, 2017](#)) or have overly vague representations that could slow lexical development ([Buckler & Johnson, under review](#); [Durrant et al., 2014](#)), as they accept (or at least ignore) mispronunciations they have not heard in either of their native variants. Still other work suggests that these differences do not impact vocabulary development ([Fung et al., under review](#)). There is also evidence that exposure to more accent variation at home affects adaptation to novel accents ([Fung, 2025](#); [Kartushina et al., 2022](#)). These preliminary findings point to the exciting possibility that, as in the study of infant bilingual development, there is no one trajectory, and that the specific patterns observed are a result of an infant’s particular input conditions.

5. The link between social and language variation

At roughly the same time that infant speech perception researchers began considering accent variation, a similar revolution was taking place in the study of social development. In 2007, a highly influential paper demonstrated that 10-month-old infants were more likely to reach for a toy offered by a speaker of their own language than by a speaker of an unfamiliar language ([Kinzler et al., 2007](#)). This paper paved the way for a new line of inquiry into how infants and toddlers might carve up their social world based on language. It turned out that infants were sensitive to more than just visually apparent social categories, like those based on race. Infants used both language and accent to decide who would like the same foods, who would be more likely to show affiliative behavior, and even who might have more relevant information for them ([Begus et al., 2016](#); [Lieberman et al., 2016](#); [Lieberman et al., 2017](#)).

Initially, this line of inquiry proceeded relatively independently of research in language development. But social categories are linked to patterns of accent variation. As the field of sociolinguistics has long known, language use cannot be studied independently of the social context in which it is embedded. Recently, researchers in infant speech perception have begun to heed this call, moving from the study of accent variation in a vacuum to the realization that it is not possible to understand speech development without reference to the social world. Indeed, initial studies have revealed surprisingly early links between these domains. Even 16 month olds have been shown to interpret speech information differently depending on the social category of the person producing it. In one study ([Weatherhead & White, 2018](#)), infants saw images of either same-race or other-race individuals and heard words produced in an unfamiliar accent. Although infants initially treated the unfamiliar pronunciations as novel words for the same-race speaker, they did not treat these same unfamiliar pronunciations that way for the other-race speaker. Moreover, they were faster to learn the new pronunciations over time for the other race speaker. This suggests that infants had linked familiar pronunciations to familiar race individuals. It also suggests that providing more social information might paradoxically make the processing of novel varieties easier.

Further interaction between researchers studying language and social development could be key to better understanding social cognition as well as speech development.

6. What can we learn in the future from studying infants' and toddlers' treatment of accent variation?

In the 25 years since an infant speech perception study first considered accent differences (and just 15 years since we first asked how accent differences might affect infants' word recognition), we have learned a great deal: young learners are not overcome by accent variation, as one would surely predict if they were rigidly mapping unique phonetic forms to unique meanings. Instead, infants have the tools to be able to reinterpret speech detail and update their representations to handle new varieties. Moreover, at least some work shows that they are able to track multiple varieties in parallel (van der Feest & Johnson, 2016; Weatherhead & White, 2016), and that they can link accent variation to social properties of speakers (Weatherhead & White, 2018; 2021). These are impressive abilities that we could not have imagined at the start of the century.

But we have just scratched the surface of what can be learned through the study of accent variation. First, what types of speech representations allow learners to manage multiple varieties and to rapidly adapt to new ones? As the debate between exemplar and abstract representations continues, we believe that the study of accent adaptation can provide critical insights – for example, are infants limited to handling accent variation through a general expansion of categories or increased tolerance? Or, do they instead show evidence of target remapping at the abstract pre-lexical level (as suggested by White & Aslin, 2011)? As we have argued elsewhere, we believe that abstract representations and an adult-like speech processing architecture are necessary to account for these abilities. But this claim requires additional empirical support.

In addition to learning more about the nature of infants' speech representations, we can also learn more about how links between social and language variation develop, and how such links are represented. In adults, some social dimensions are more likely to be associated with language variation than others (Rácz et al., 2020; Ryken et al., 2024). But it is not clear where these biases come from. Are these pre-existing biases that learners bring to the task of language acquisition? Or are these developed through experience with variation in the environment? These questions are impossible to answer looking at adults alone. Thus far, infants and children have been shown to link the way people talk to their cultural preferences, race, and affiliative behaviors (Weatherhead et al., 2016; Weatherhead & White, 2021). But do they have even earlier biases about the specific social features and language features that *could* be subject to variation, or about how these features might be linked (for example, do they expect that gender could be a dimension of variation and that it might be linked to specific kinds of language variation)?

To make progress on any of these questions, we will need to make a concerted effort going forward to integrate considerations of accent variation at all levels. For example, our corpus studies will need to consider accent differences (which cannot be captured in idealized transcriptions of the input). And, long after it has become common practice to ask caregivers of participants whether their children are exposed to one vs. more than one language, it is still rare for them to be asked whether their children are exposed to more than one variety of a single language (and what specific varieties). If we do not know who our participants truly are, how can we hope to fully understand the relation between input and language outcomes?

7. Conclusions

The field of infant speech perception has made remarkable strides since its inception 50 years ago. The turn of the 21st century saw a renewed focus on the role of the input, and interest in relating variation in infants' input to their speech and language development. This has led to more serious consideration of learners across a broader range of contexts, which has already had profound influences on our thinking. However, until recently, the field has largely ignored variation in accent. We are now in the position to take up the challenge and consider input in all of its diversity – including accent – and to use the increasingly sophisticated methodological and analytical tools available to us to build theories that account for all language learning environments.

CRediT authorship contribution statement

Elizabeth Johnson: Conceptualization, Writing – original draft, Writing – review & editing **Katherine White:** Conceptualization, Writing – original draft, Writing – review & editing.

Data availability

No data was used for the research described in the article.

References

- Anderson, J. L., Morgan, J. L., & White, K. S. (2003). A statistical basis for speech sound discrimination. *Language and Speech*, 46(2-3), 155–182. <https://doi.org/10.1177/002383090304600206>
- Begus, K., Gliga, T., & Southgate, V. (2016). Infants' preferences for native speakers are associated with an expectation of information. *Proceedings of the National Academy of Sciences*, 113(44), 12397–12402. <https://doi.org/10.1073/pnas.1603261113>
- Bergelson, E., Soderstrom, M., et al. (2024). Everyday language input and production in 1,001 children from six continents. *Proceedings of the National Academy of Sciences*, 120(52), Article e2300671120. <https://doi.org/10.1073/pnas.2300671120>

- Bergelson, E., & Swingle, D. (2012). At 6-9 months, human infants know the meanings of many common nouns. *Proceedings of the National Academy of Sciences*, 109(9), 3253–3258. <https://doi.org/10.1073/pnas.1113380109>
- Bergelson, E., Casillas, M., Soderstrom, M., Seidl, A., Warlaumont, A. S., & Amatuni, A. (2019). What do North American babies hear? A large-scale cross-corpus analysis. *Developmental Science*, 22(1), Article e12724. <https://doi.org/10.1111/desc.12724>
- Best, C. T., Tyler, M. D., Gooding, T. N., Orlando, C. B., & Quann, C. A. (2009). Development of phonological constancy: toddlers' perception of native- and Jamaican-accented words. *Psychological Science*, 20, 539–542. <https://doi.org/10.1111/j.1467-9280.2009.02327.x>
- Buckler, H., Oczak-Arsic, S., Siddiqui, N., & Johnson, E. K. (2017). Input matters: Speed of word recognition in 2-year-olds exposed to multiple accents. *Journal of Experimental Child Psychology*, 164, 87–100. <https://doi.org/10.1016/j.jecp.2017.06.017>
- Buckler, H., & Johnson, E.K. (under review). It's hey Jade, not hey Jude: accent variation and 6-month-olds' sensitivity to mispronunciations in their own name.
- Bulgarelli, F., Mielke, J., & Bergelson, E. (2021). Quantifying talker variability in North-American infants' daily input. *Cognitive Science*, 46(1), Article e13075. <https://doi.org/10.1111/cogs.13075>
- Butler, J., Floccia, C., Goslin, J., & Panneton, R. (2011). Infants' discrimination of familiar and unfamiliar accents in speech. *Infancy*, 16(4), 392–417. <https://doi.org/10.1111/j.1532-7078.2010.00050.x>
- Byers-Heinlein, K., Burns, T. C., & Werker, J. F. (2010). The roots of bilingualism in newborns. *Psychological Science*, 21(3), 343–348. <https://doi.org/10.1177/0956797609360758>
- Cartmill, E. A., Armstrong, B. F., III, Gleitman, L. R., Goldin-Meadow, S., Medina, T. N., & Trueswell, J. C. (2013). Quality of early parent input predicts child vocabulary 3 years later. *Proceedings of the National Academy of Sciences*, 110(28), 11278–11283. <https://doi.org/10.1073/pnas.1309518110>
- Casillas, M., Brown, P., & Levinson, S. C. (2020). Early language experience in a Tzeltal Mayan village. *Child Development*, 91(5), 1819–1835. <https://doi.org/10.1111/cdev.13349>
- Cooper, A., Paquette-Smith, M., Bordignon, C., & Johnson, E. K. (2022). The influence of accent distance on perceptual adaptation in toddlers and adults. *Language Learning and Development*, 19(1), 74–94. <https://doi.org/10.1080/15475441.2022.2047688>
- Cristia, A. (2011). Fine-grained variation in caregivers' /s/ predicts their infants' /s/ category. *Journal of the Acoustical Society of America*, 129(5), 3271–3280. <https://doi.org/10.1121/1.3562562>
- Cristia, A., Dupoux, E., Gurven, M., & Stieglitz, J. (2019). Child-directed speech is infrequent in a forager-farmer population: A time allocation study. *Child Development*, 90(3), 759–773. <https://doi.org/10.1111/cdev.12974>
- Cristia, A., Minagawa-Kawai, Y., Egorova, N., Gervain, J., Filippin, L., Cabrol, D., & Dupoux, E. (2014). Neural correlates of infant accent discrimination: An fNIRS study. *Developmental Science*, 17(4), 628–635. <https://doi.org/10.1111/desc.12160>
- Durrant, S., Delle Luche, C., Cattani, A., & Floccia, C. (2014). Monodialectal and multidialectal infants' representation of familiar words. *Journal of Child Language*, 42(2), 447–465. <https://doi.org/10.1017/S0305000914000063>
- Floccia, C., Delle Luche, C., Durrant, S., Butler, J., & Goslin, J. (2012). Parent or community: Where do 20-month-olds exposed to two accents acquire their representations of words? *Cognition*, 124, 95–100. <https://doi.org/10.1016/j.cognition.2012.03.011>
- Foushee, R., & Srinivasan, M. (2024). Infants who are rarely spoken to nevertheless understand many words. *Proceedings of the National Academy of Sciences*, 121(23), Article e2311425121. <https://doi.org/10.1073/pnas.2311425121>
- Fung, P. (2025). *Navigating Variability: Language Development in Linguistically Diverse Environments* (Doctoral Dissertation). University of Toronto.
- Fung, P., Buckler, H., & Johnson, E.K. (under review). Vocabulary growth amongst children in a linguistically diverse community: A Large-scale study.
- Halle, P., & deBoyssson-Bardies, B. (1994). Emergence of an early receptive lexicon: Infants' recognition of words. *Infant Behavior and Development*, 17(2), 119–129. [https://doi.org/10.1016/0163-6383\(94\)90047-7](https://doi.org/10.1016/0163-6383(94)90047-7)
- Hart, B., & Risley, T. (1995). *Meaningful differences in the everyday experience of young American children*. Baltimore, MD: Paul H. Brookes.
- Huttenlocher, J., Vasilyeva, M., Waterfall, H. R., Vevea, J. L., & Hedges, L. V. (2007). The varieties of speech to young children. *Developmental Psychology*, 43(5), 1062–1083. <https://doi.org.proxy.lib.uwaterloo.ca/10.1037/0012-1649.43.5.1062>
- Johnson, E. K., van Heugten, M., & Buckler, H. (2022). Navigating accent variation: A developmental perspective. *Annual Review of Linguistics*, 8, 365–387. <https://doi.org/10.1146/annurev-linguistics-032521-053717>
- Jones, Z., Yan, Q., Wagner, L., & Clopper, C. (2017). The development of dialect classification across the lifespan. *Journal of Phonetics*, 60, 20–37. <https://doi.org/10.1016/j.wocn.2016.11.001>
- Jusczyk, P. W., Cutler, A., & Redanz, N. (1993). Preference for the predominant stress patterns of English words. *Child Development*, 64, 675–687. <https://doi.org/10.2307/1131210>
- Jusczyk, P. W., Luce, P. A., & Charles-Luce, J. (1994). Infants' sensitivity to phonotactic patterns in the native language. *Journal of Memory and Language*, 33(5), 630–645. <https://doi.org/10.1006/jmla.1994.1030>
- Kartushina, N., Rosslund, A., & Mayor, J. (2022). Toddlers raised in multi-dialectal families learn words better in accented speech than those raised in monodialectal families. *Journal of Child Language*, 49(6), 1093–1118. <https://doi.org/10.1017/S0305000921000520>
- Kinzler, K. D., Dupoux, E., & Spelke, E. S. (2007). The native language of social cognition. *Proceedings of the National Academy of Sciences*, 104, 12577–12580. <https://doi.org/10.1073/pnas.0705345104>
- Kitamura, C., Panneton, R., & Best, C. T. (2013). The development of language constancy: Attention to native versus nonnative accents. *Child Development*, 84(5), 1686–1700. <https://doi.org/10.1111/cdev.12068>
- Kuhl, P. K., Williams, K. A., Lacerda, F., Stevens, K. N., & Lindblom, B. (1992). Linguistic experience alters phonetic perception in infants by 6 months of age. *Science*, 255(5044), 606–608. <https://doi.org/10.1126/science.173636>
- Kuhl, P. K., Conboy, B. T., Coffey-Corina, S., Padden, D., Rivera-Gaxiola, M., & Nelson, T. (2008). Phonetic learning as a pathway to language: New data and native language magnet theory expanded (NLM-e). *Philosophical Transactions of the Royal Society B*, 363, 979–1000. <https://doi.org/10.1098/rstb.2007.2154>
- Leopold, W. (1949). *Speech development of a bilingual child*. Evanston, Ill: Northwestern University Press.
- Lewis, M., Cristiano, V., Lake, B. M., Kwan, T., & Frank, M. C. (2020). The role of developmental change and linguistic experience in the mutual exclusivity effect. *Cognition*, 198, Article 104191. <https://doi.org/10.1016/j.cognition.2020.104191>
- Liberman, Z., Woodward, A. L., & Kinzler, K. D. (2017). Preverbal infants infer third-party social relationships based on language. *Cognitive Science*, 41(S3), 622–634. <https://doi.org/10.1111/cogs.12403>
- Liberman, Z., Woodward, A. L., Sullivan, K. R., & Kinzler, K. D. (2016). Early emerging system for reasoning about the social nature of food. *Proceedings of the National Academy of Sciences*, 113(34), 9480–9485.
- Liu, H.-M., Kuhl, P. K., & Tsao, F.-M. (2003). An association between mothers' speech clarity and infants' speech discrimination skills. *Developmental Science*, 6(3), F1–F10. <https://doi.org/10.1111/1467-7687.00275>
- Loukatou, G., Scaff, C., Demuth, K., Cristia, A., & Havron, N. (2022). Child-directed and overheard input from different speakers in two distinct cultures. *Journal of Child Language*, 49(6), 1173–1192. <https://doi.org/10.1017/S0305000921000623>
- Mampe, B., Friederici, A. D., Christophe, A., & Wermke, K. (2009). Newborns' cry melody is shaped by their native language. *Current Biology*, 19(23), 1994–1997. <https://doi.org/10.1016/j.cub.2009.09.064>
- Mehler, J., Jusczyk, P. W., Lambert, G., Halsted, N., Bertoncini, J., & Amiel-Tison, C. (1988). A precursor of language acquisition in young infants. *Cognition*, 29, 143–178. [https://doi.org/10.1016/0010-0277\(88\)90035-2](https://doi.org/10.1016/0010-0277(88)90035-2)
- Mulak, K. E., Best, C. T., Tyler, M. D., Kitamura, C., & Irwin, J. R. (2013). Development of phonological constancy: 19-month-olds, but not 15-month-olds, identify words in a non-native regional accent. *Child Development*, 84(6), 2064–2078. <https://doi.org/10.1111/cdev.12087>
- Nazzi, T., Jusczyk, P. W., & Johnson, E. K. (2000). Language discrimination by English-learning 5-month-olds: Effects of rhythm and familiarity. *Journal of Memory and Language*, 43(1), 1–19. <https://doi.org/10.1006/jmla.2000.2698>
- Pancsofar, N., & Vernon-Feagans, L. (2006). Mother and father language input to young children: Contributions to later language development. *Journal of Applied Developmental Psychology*, 27(6), 571–587. <https://doi.org/10.1016/j.appdev.2006.08.003>

- Paquette-Smith, M., & Johnson, E. K. (2015). Spanish-accented English is Spanish to English-learning 5-month-olds. *Proceedings of 18th International Congress of Phonetic Sciences*, 18.
- Phan, J., & Houston, D. M. (2008). Infant Dialect Discrimination. *Research on Spoken Language Processing Progress Report*. Indiana University.
- Polka, L., & Werker, J. F. (1994). Developmental changes in perception of nonnative vowel contrasts. *Journal of Experimental Psychology: Human Perception and Performance*, 20(2), 421–435. <https://doi.org/10.1037/0096-1523.20.2.421>
- Potter, C. E., & Saffran, J. R. (2017). Exposure to multiple accents supports infants' understanding of novel accents. *Cognition*, 166, 67–72. <https://doi.org/10.1016/j.cognition.2017.05.031>
- Schmale, R., & Seidl, A. (2009). Accommodating variability in voice and foreign accent: Flexibility of early word representations. *Developmental Science*, 12, 583–601. <https://doi.org/10.1111/j.1467-7687.2009.00809.x>
- Schmale, R., Cristia, A., Seidl, A., & Johnson, E. K. (2010). Developmental changes in infants' ability to cope with dialect variation in word recognition. *Infancy*, 15, 650–662. <https://doi.org/10.1111/j.1532-7078.2010.00032.x>
- Tincoff, R., & Jusczyk, P. W. (1999). Some beginnings of word comprehension in 6-month-olds. *Psychological Science*, 10(2), 172–175. <https://doi.org/10.1111/1467-9280.0012>
- Rácz, P., Hay, J. B., & Pierrehumbert, J. B. (2020). Not all indexical cues are equal: Differential sensitivity to dimensions of indexical meaning in an artificial language. *Language Learning*, 70(3), 848–885. <https://doi.org/10.1111/lang.12402>
- Ramírez-Esparza, N., García-Sierra, A., & Kuhl, P. K. (2014). Look who's talking: Speech style and social context in language input to infants are linked to concurrent and future speech development. *Developmental Science*, 17, 880–891. <https://doi.org/10.1111/desc.12172>
- Romeo, R. R., Leonard, J. A., Robinson, S. T., West, M. R., Mackey, A. P., Rowe, M. L., & Gabrieli, J. D. E. (2018). Beyond the 30-Million-Word Gap: Children's conversational exposure is associated with language-related brain function. *Psychological Science*, 29(5), 700–710. <https://doi.org/10.1177/0956797617742725>
- Roy, B. C., Frank, M. C., DeCamp, P., Miller, M., & Roy, D. (2015). Predicting the birth of a spoken word. *Proceedings of the National Academy of Sciences*, 112(41), 12663–12668. <https://doi.org/10.1073/pnas.1419773112>
- Ryken, A. M., Tupper, E., & Weatherhead, D. (2024). Learning linguistic diversity: Listeners have race-based linguistic expectations, but only for phonological variation. *Journal of Experimental Psychology: General*, 153(11), 2918–2930. <https://doi.org/10.1037/xge0001560>
- Schmale, R., Cristia, A., & Seidl, A. (2012). Toddlers recognize words in an unfamiliar accent after brief exposure. *Developmental Science*, 15, 732–738. <https://doi.org/10.1111/j.1467-7687.2012.01175.x>
- Schmale, R., Seidl, A., & Cristia, A. (2015). Mechanisms underlying accent accommodation in early word learning: Evidence for general expansion. *Developmental Science*, 18, 664–670. <https://doi.org/10.1111/desc.12244>
- Shneidman, L. A., & Goldin-Meadow, S. (2012). Language input and acquisition in a Mayan village: how important is directed speech? *Developmental Science*, 15, 659–673. <https://doi.org/10.1111/j.1467-7687.2012.01168.x>
- Soderstrom, M., Grauer, E., Dufault, B., & McDivitt, K. (2018). Influences of number of adults and adult:child ratios on the quantity of adult language input across childcare settings. *First Language*, 38(6), 563–581. <https://doi.org/10.1177/014272371878501>
- Sperry, D. E., Sperry, L. L., & Miller, P. J. (2019). Reexamining the verbal environments of children from different socioeconomic backgrounds. *Child Development*, 90(4), 1303–1318. <https://doi.org/10.1111/cdev.13072>
- van der Feest, S. V. H., & Johnson, E. K. (2016). Input driven differences in toddlers' perception of a disappearing phonological contrast. *Language Acquisition*, 23, 89–111. <https://doi.org/10.1080/10489223.2015.1047096>
- van Heugten, M., & Johnson, E. K. (2014). Learning to contend with accents in infancy: Benefits of brief speaker exposure. *Journal of Experimental Psychology: General*, 143, 340–350. <https://doi.org/10.1037/a0032192>
- van Heugten, M., & Johnson, E. K. (2017). Input matters: Multi-accent language exposure affects word form recognition in infancy. *The Journal of the Acoustical Society of America*, 142(2), EL196–EL200. <https://doi.org/10.1121/1.4997604>
- Weatherhead, D., & White, K. S. (2016). He says potato, she says potahto: Young infants track talker-specific accents. *Language Learning and Development*, 12(1), 92–103. <https://doi.org/10.1080/15475441.2015.1024835>
- Weatherhead, D., White, K. S., & Friedman, O. (2016). Where are you from? Preschoolers infer background from accent. *Journal of Experimental Child Psychology*, 143, 171–178. <https://doi.org/10.1016/j.jecp.2015.10.011>
- Weatherhead, D., & White, K. S. (2018). And then I saw her race: Race-based expectations affect infants' word processing. *Cognition*, 177, 87–97. <https://doi.org/10.1016/j.cognition.2018.04.004>
- Weatherhead, D., & White, K. S. (2021). Toddlers link social and speech variation during word learning. *Developmental Psychology*, 57(8), 1195. <https://doi.org/10.1037/dev0001032>
- Werker, J. F., & Tees, R. C. (1984). Cross-language speech perception: Evidence for perceptual reorganization during the first year of life. *Infant Behavior and Development*, 7(1), 49–63. [https://doi.org/10.1016/S0163-6383\(84\)80022-3](https://doi.org/10.1016/S0163-6383(84)80022-3)
- White, K. S., & Aslin, R. N. (2011). Adaptation to novel accents by toddlers. *Developmental Science*, 14(2), 372–384. <https://doi.org/10.1111/j.1467-7687.2010.00986.x>