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BRIEF REVIEW



# Living in Pasteur's Quadrant: How Conversational Duets Spark Language at Home and in the Community

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**ABSTRACT**

In 1995 scientists, educators, and policymakers were startled by the claim that low-income children in the United States heard 30 million fewer words than their middle-income peers. Because language is the single best predictor of later academic readiness, this gap can have consequences for children in school and beyond. Language researchers know much about the types of interactions that foster a strong foundation in language learning and about the kinds of interactions that can narrow the disparities. This article reviews the growing consensus in the field about how to reduce language gaps and challenges scientists to put the latest research on early language in the hands of parents and teachers who work with children every day. Our work connects the lab, the home, and the community and demonstrates a synergy between basic and applied science noted in the classic, *Pasteur's Quadrant*.

## Introduction

In 1995 Hart and Risley published their highly influential book, *Meaningful Differences in the Everyday Experience of Young American Children*. Their well-cited—and now replicated—findings shocked the community (Fernald, Marchman, & Weisleder, 2013; Hoff, 2003). Lower-income children hear on average 30 million fewer words than their middle- to high-income peers by age 3. Dubbed the "30-Million Word Gap," this research started a policy narrative about the importance of early language learning for later school readiness and school success—a narrative that would impact research priorities, public policy, and institutional practice. Perhaps we just needed to speak more to young children to bolster their language skills.

The findings of Hart and Risley (1995) motivated programs of research focused on the quantity of language (Leffel & Suskind, 2013). Yet, Hart and Risely were equally interested in the *quality* of early language input and interaction, a factor that is gaining momentum in a number of laboratories (e.g., Cartmill et al., 2013; Goldin-Meadow et al., 2014; Hirsh-Pasek et al., 2015; Rowe, 2012). Differences in the quantity and quality of early input have been linked to children's later language and reading scores (Dickinson, Golinkoff, & Hirsh-Pasek, 2010; Hoff, 2013). In fact, recent research from our team demonstrates that early language scores are the single best predictor not only of later language but of math, social, and literacy outcomes (Pace et al., 2017). However, there remains a large gap between what we know in the science and how that might be used in practice. The many caregiver–implemented early language programs developed since 1995 (Leffel & Suskind, 2013) suggest that we are just barely moving the needle forward. Reardon, Waldfogel, and Bassok (2016) estimate that it would take approximately 60 to

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110 years to close the school readiness gap if we continued at the rate observed between 1998 and 2010.

In some ways the Hart and Risley (1995) research represented and further fueled a shift in the scientific framework for early language research. Specifically, there has been a growing understanding that we need to know what counts as high-quality early language interactions beyond just the quantity of words children hear (Cartmill et al., 2013; Goldin-Meadow et al., 2014; Rowe, 2012), hence a focus on interaction quality, language at the discourse level, and what in our research we have termed the "conversational duet" (Hirsh-Pasek et al., 2015). Furthermore, translating that knowledge into applied, evidence-based approaches to improving the lives of at-risk children has become a top priority. This prioritization of translation and application is consistent with the trend in the scientific community more broadly.

Around the same time that Hart and Risley (1995) published their seminal book, political scientist and Brookings fellow, Donald Stokes, penned another influential book, *Pasteur's Quadrant* (1997). Stokes observed the unhealthy rift between what scholars referred to as basic versus applied science. He offered a model for rectifying this great divide. He suggested that we devise a 2 × 2 grid that cross-cuts what he termed "quest for understanding" and "consideration of use." It is in this model that we find the basic scientist who has no concern for application (e.g., the physicist Bohr who is credited with discovering the atom or Marie Curie who worked with radium) and the applied scientist like Edison who invented the lightbulb. There is also, however, the scientist who cares deeply about scientific advance while at the same time thinking about consideration of use. Stokes suggested that Pasteur offered a perfect example of the translational scientist who made significant discoveries in chemistry as well as in the field of vaccination.

It is from *Pasteur's Quadrant* (Stokes, 2011) that we have approached our research on early language interaction quality and intervention. Basic work still fuels our interest in improving language and academic outcomes for children. However, we now understand that basic research can be conducted with an eye toward translation and application in an evidence-based model. If we can find a way to help caregivers engage children and support language learning, we might be able to buttress language scores by age 3. This early intervention could improve long-term academic and life outcomes. At the core of our mission sits the *conversational duet*, so-called because interactions in which both adult and child communicate together offers the high-quality context for growing both quantity and quality of language skills that are foundational for learning.

## How to nurture conversational duets?

Inspired by Hart and Risley's (1995) findings, we joined a number of research teams to ask how we might jumpstart children's language learning, especially for low socioeconomic status families. Some groups, like *Too Small to Fail* and *Vroom* (Galinsky, Bezos, McClelland, Carlson, & Zelazo, 2017), initiated community-wide efforts to encourage parents to talk, read, and sing to their children or to use brain building tips. These initiatives are beginning to change the culture of childrearing (Reardon, Waldfogel, & Bassok, 2016). Indeed, we were part of a recent collaboration with a team in Tulsa, Oklahoma, a community that is part of the *Too Small to Fail* initiative. We noticed that the baseline conversation in low-income mothers in Tulsa was higher than the baseline conversation in Philadelphia, suggesting that community-wide efforts like Too Small to Fail and Vroom are having an impact there.

These programs are also starting to address the question of *quality* interactions between caregiver and child, what we are calling the *conversational duet* and what Shonkoff (2017) refers to as "serve and return." Rowe (2012) has done extensive research in the basic science of quality language. For example, she found that the use of diverse vocabulary and decontextualized language (e.g., narratives) by caregivers were critical, positive predictors of child vocabulary outcomes at 42 and 54 months (Rowe, 2012). Similarly, in Hirsh-Pasek et al. (2015) we used data from the National Institute of Child Health and Human Development Study of Early Child Care and analyzed the

ways in which back-and-forth conversation between parents when children were age 2 to see how these conversations might influence child language outcomes at age 3. Further, one might expect that the quality of the interactions should vary normally *within* rather than merely across parental income levels. Thus, we looked only within low-income families to provide a strong test of our hypothesis.

We constituted three groups of children based on how they did on the language assessment test given at age 3 (Reynell, 1991): those who scored very well, those who scored in the middle, and those who were struggling language learners. Could experimenters, blind to the children's outcomes, analyze the parent–child interactions when the children were age 2 and predict where they would land a year later? They could. Furthermore, fluid conversational duets were among the key factors that allowed us to make that prediction, accounting for 26% of the variability in the low-income children's scores (Hirsh-Pasek et al., 2015). Others have noted similar relationships (Cartmill et al., 2013).

So, what is it about conversational duets that made the difference? Research was beginning to isolate one key factor—contingent language responding (Tamis-LeMonda, Kuchirko, & Song, 2014). Caregivers can respond to children in a temporally contingent (Bornstein & Tamis-Lemonda, 1997) way by supporting the flow of conversation without pauses and breaks. They can respond in a semantically contingent way that continues the meaning of the discourse (McGillion et al., 2013). The fusion of these two factors constitutes *adaptive contingency* (Reed et al., 2016), and this factor might be foundational in predicting conversational language and language outcomes more broadly.

The role of contingency in an experimental paradigm was explicitly tested using video chat as a conversational medium. We know that 2-year-olds can learn words if they hear them from a live experimenter (Roseberry, Hirsh-Pasek, Parish-Morris, & Golinkoff, 2009). We also know that children are less likely to learn the same words when they were delivered on television (Kuhl, 2010). One difference between the two conditions is that television screens are two-dimensional and people are three-dimensional. Another difference is that live people preserve adaptive contingency, whereas television programs violate this contingency. Could 2-year-old children learn the same two words if they heard them over video chat, a format that maintains the contingency within the limits of a two-dimensional screen? Would the results look more like they did in the live condition or would they parallel the findings in the television condition? Thirty-six 2-year olds later we had the answer: Video chat was indistinguishable from the live condition (Roseberry, Hirsh-Pasek, & Golinkoff, 2014).

Preserving contingency allows for learning and offers a sufficient condition for our claim that language learning requires conversational duets. To address whether it is a *necessary* condition, one might ask what happens when you violate or interrupt the contingency. Here we turned to a great natural experiment, the use of cell phones, where rings and texts are constantly interrupting the flow of everyday interactions. In a within-subject design, 2-year olds were taught exactly the same two words used in the above experiments. Parents came into the lab and were asked to teach their children the words. They were also informed that we would give them a cell phone call at some point during the experiment and that they were to answer the call. Half the parents would be interrupted during word one and half during word two. We hypothesized that even though parents would spend exactly the same amount of time teaching the interrupted word and the uninterrupted word, the interruption itself would derail learning. That is precisely what happened (Reed, Hirsh-Pasek, & Golinkoff, 2017).

Contingency appears to be a key factor in establishing the ingredients for word learning. We had established two facts that might be of interest in the practical world. Grandparents could cheer, because the American Academy of Pediatrics suggested screen time in the form of video chat was an acceptable type of screen time (Radesky & Christakis, 2016). Also, parents would have to take note that their behavior with cell phones might be conversation closers with their children.

## Conversational duets with the community

Quantifying key ingredients that make high-quality early language interactions is difficult, but translating these findings into effective interventions to address the achievement gap is even more challenging. How do we encourage parents, teachers, and caregivers to engage in conversational duets with young children? Our approach was to tackle this question from many vantage points, such as the home and community.

### *In the Home*

The Duet Project—so named for our key construct, the conversational duet—is a community-based participatory research initiative conducted in the city of Philadelphia. The Duet Project is designed to improve early caregiver–child communication interactions and promote better language outcomes and school readiness for very low-income children. Our partner organization, the Maternity Care Coalition, serves 800 of the lowest income families in the region and runs not only a home-visiting program for mothers but also several Early Head Start Preschools. The Maternity Care Coalition is immersed in the cultural needs of families in Philadelphia and is familiar with the parents in underserved neighborhoods. Although they could serve as a conduit for families, by using the community-based participatory research framework, we asked that they take on a larger role in design and assessment. As knowledgeable and familiar members of the low-income community, we considered it imperative that they co-designed the materials we developed to enrich early language growth. Sitting with us every step of the way, decisions were made to optimize the stimuli that would be used for intervention, the scripts used by home visitors, and even the data collection efforts.

The science was foundational to the project—the translation and application was structured around a set of research-based principles. The principles focused on (1) promoting *knowledge of child development* and behavioral awareness during caregiver–child interaction, (2) *creating opportunities* for communication everywhere and every day, (3) encouraging back-and-forth *conversational duets* between caregivers and children, (4) using *scaffolding* to provide just enough support to the child and encourage independence, and (5) *harmonizing*, which means using the principles together strategically to enhance interaction quality and limit communication breakdown. One module was created to target each of the principles, and the multimedia modules were presented to caregivers in their homes. The multimedia modules served as the platform for demonstrating and teaching the components of the conversational duet. We hypothesized that strong science wrapped in community-based language and packaging would allow us to first train the home visitors and teachers who could then be the providers who taught language-enhancing techniques to parents and children (Alper et al., 2016).

The data are trickling in, and we have come to learn how much harder it is to live in "Pasteur's quadrant" than in the lab with willing volunteers who come to us for our research. In real life parents scramble to get their children fed and ensure they are safe. Language learning is not on the top of the to-do list. Scheduling is difficult and follow-through sporadic. Nonetheless, our first nuggets of data suggest that the teachers who have experienced our training are indeed benefitting, both in terms of their views on child development and in the ways in which they insert more conversational duets into their classrooms. Research shows that rich conversations are sparse in most preschool classrooms; teachers tend to use minimal sophisticated vocabulary and dominate the conversation during free play (Dickinson & Porche, 2011). Furthermore, teachers and childcare providers can make a large difference in helping children narrow the language gap (Vernon-Feagans & Bratsch-Hines, 2013). Although it is too early to test the outcomes, our first returns look promising for both the teacher and parent data.

### *In the community*

The Duet Project is designed to stimulate the kinds of interactions that build strong language skills. Might it be possible to do a metaphorical "surround sound" that prompted these kinds of interactions in everyday community places outside of the home, in places where people go? It turns out that even if children go to child care or preschool for a full day, they are in school for only 20% of their *waking* time (Meltzoff et al., 2009). What are they doing during the other 80%? How might we engineer family-friendly environments that organically encourage learning? Enter Learning Landscapes.

Learning Landscapes capitalizes on two broad initiatives: urban revitalization and interest in early childhood as a field. Urban revitalization is the makeover of cities and neighborhoods in ways that are more livable and family friendly. With over 70% of the world's children living in urban areas by the year 2050, urban revitalization is essential. The interest in early childhood as a field was cemented in 2015 when the United Nations Mandate asserted that children are the basis for all dimensions of sustainable development. They have a right to thrive, develop to their full potential, and live in a sustainable world. As such, children should be at the center of the post-2015 Sustainable Development Goals. At the intersect lies Learning Landscapes, an initiative with the Brookings Institution with a research hub through Temple University.

Among our first forays into the community setting was a makeover of supermarkets into potential hubs for conversational duets. Imagine walking through the supermarket and seeing child-friendly prompts for parents in the dairy and frozen vegetable sections. Signs sport, "Healthy language helps children grow," and prompts suggest things like, "I come from a cow" (near the yogurt section), "Can you find anything else that comes from a cow?" Signs like these were used in the first Philadelphia and Delaware stores where we canvassed both low-income and middle-income neighborhoods. We manipulated whether the signs were up or down to assess their impact on family talk. When the signs were up, low-income families used 33% more language with their children than when the signs were down. For middle-income families there was no impact from the signage (Ridge, Weisberg, Ilgaz, Hirsh-Pasek, & Golinkoff, 2015).

This research is ongoing in South Africa and was the impetus for prompts that have now been used on playgrounds and in laundromats by the *Too Small to Fail* initiative. Interestingly, in a mixed neighborhood store that serves both middle and lower income families in Tulsa, the level of conversation use was so high at the start that there were no gains from sign usage. This finding, although preliminary, suggests that in places where the community messaging has been successful there might be a threshold after which further light-touch interventions are not profitable (Morris et al., 2017, personal communication).

Learning Landscapes is a new and currently untested project that takes the science directly to the streets. In one incarnation, dubbed Urban Thinkscape, we redesigned public spaces like bus stops to include Science, Technology, Engineering and Mathematics (STEM) games and architecture to spur rich language that should invite the kinds of conversations that promote learning. Testing is ongoing.

Another of our projects in progress, Parkopolis, offers a human-sized board game designed to elicit conversations around mathematics and scientific reasoning. With dice remade to include fractions, children and their caregivers can move 1.5 spaces rather than just 1 to 12 spaces, giving them a guaranteed way of talking about and adding fractions. The game is also populated with cards that ask children to play with patterns, learn shapes, and reason as they move along the spaces, and each card is derived directly from current and well-established findings in the scientific literature. Indeed, Parkopolis is an example of guided play at its best (Hassinger-Das, Hirsh-Pasek, & Golinkoff, 2017; Weisberg, Hirsh-Pasek, & Golinkoff, 2013). Parkopolis was first tested in Switzerland during the summer of 2017, and the preliminary data suggest that the game encouraged exactly the interactions it was designed to encourage.

The community outreach projects illustrated in Learning Landscapes projects are first tested for proof of concept and go through an iterative phase (Schindler, Fisher, & Shonkoff, 2017) before they

are finalized. The scientific research becomes more quasi-experimental and must meet the highest standards of basic research and publication.

### *Measuring success*

Hart and Risley (1995) challenged those in the language field to think about intervention—about how we might work with typically developing children to enhance their language outcomes. How would we know if we successfully encouraged parent–child interaction and modified outcomes? In our work three research tools are being mustered to address this question: LENA, QUILS, and old-fashioned observation.

The Language Environment Analysis (LENA) system is a sophisticated and wearable recording system that captures both the caregiver's talk and the child's responses. Tracking both the amount of language and the conversational turns, LENA offers a powerful tool for approximating the quantity and quality of language outcomes. One beautiful example of a well-run study using LENA as outcome was Weber, Fernald, and Diop's (2017) intervention in Senegal. There they introduced some language learning techniques into a cultural climate where talking to children was considered taboo. Talking to a child invited the evil spirits and could actually do damage to the very person that parents want to protect. Even there, however, these techniques helped parents see the benefit of encouraging early language skills with parents. Their work offers a stunning portrait of language intervention with positive outcomes and of basic research that has relevance (Weber et al., 2017).

The Quick Interactive Language Screener, or QUILS, is designed for children ages 3 through 5 years and is again an example of how one can use basic research to solve applied problems. With 45 items drawn directly from the literature and tested to discriminate by age and ability, the QUILS examines children's knowledge of vocabulary, syntax (Product), and their ability to learn new words (Process; Golinkoff et al., 2017). This screener allows us to chart development in 3- to 5-year-olds for both monolingual English-speaking children and bilingual English- and Spanish-speaking children.

Finally, our measures of increased parent–child interaction and targeted language by children (number words, spatial terms) is being conducted through reliable observation of parents and children in situ, be it in the grocery store or at Parkopolis. Training observers to criteria and looking at reliability for observers blind to the hypotheses will allow us to fully investigate the questions that we have posed.

## Conclusion

The field of early language development has come far since Hart and Risley (1995). Scientists have discovered a great deal about the key components promoting language growth—both quantity of input and the quality of the interactions. Moving the findings from the literature to potential impact in the real world poses yet another set of challenges. Our own work, grounded in Pasteur's quadrant, has taught us a great deal about what it means to leave pristine research laboratories for more ambiguous and messy environments. Yet, as scientists we feel compelled to put the growing consensus around early-language learning in the hands of parents and teachers who work with children every day. Our work has connected the lab, the home, and the community. As we look to the future, we recognize how we will have to continue to balance research standards and practical application. Science is a vehicle for discovering the mechanisms involved and the tools that can be used to help these children leap forward. We cannot guarantee that these solutions will work when brought to scale. But with intellectual entrepreneurship and science in our tool chest, we just might be able to narrow the 30-million-word gap and to make a difference for real people.

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