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A Matter of Principle: Applying Language Science to the Classroom and Beyond

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Strong language skills are critical for developing literacy, social skills, mathematics, and executive function skills. However, homes and classrooms often do not provide the key elements necessary for improving children's language outcomes. After reviewing the evidence for the six principles of language development—which have been distilled from the language science literature—this article describes an educational intervention that was designed using these principles as a foundation. The Read–Play–Learn project is used as a model to demonstrate how the application of the six principles of language development provides a guiding blueprint for implementing language science in the real world. Barriers to application are also discussed alongside recommendations for future research expanding the use of the six principles of language development beyond the classroom and into homes and community settings.

What is the significance of this article for the general public?
This article demonstrates the efficacy of building upon a solid foundation in language science for applied work in schools, homes, and community contexts by describing a classroom language intervention with preschoolers from economically disadvantaged backgrounds built on six core principles of language development (frequency, interest, contingency, meaningfulness, diversity, and reciprocity).

Keywords: language development, education, practical application, language outcomes

Language is the single best predictor of children's later academic success (Hoff, 2013). Language production and comprehension are related to one another and, beyond their natural connection to literacy, they also facilitate social and emotional development (Roben, Cole, & Armstrong, 2013), support the learning of academic content area knowledge (LeFevre et al., 2010), and promote the growth of executive functioning skills, such as attention and working memory (Gomes, Wolfson, & Halperin, 2007; Leonard et al., 2007).

Language underpins much of what happens both in and out of school, and children who lack sufficient language and world knowledge often struggle to keep up (Hoff, 2013). Though research demonstrates that strong language skills are essential for literacy and other areas, parents (Hart & Risley, 1995) and teachers (Dickinson, 2011) often do not create sufficiently language-rich environments. Efforts to increase support

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for language skills in young children have met with varied success. One potential reason is that differences in language growth based on socioeconomic status (SES) emerge well before children begin formal schooling. Hart and Risley's (1995) groundbreaking research found that children from professional families heard, on average, 48 million words addressed to them by the age of 4, while children from low-income families only heard 13 million. This disparity is critical, because children use existing knowledge of words to help them learn new words. Multiple researchers have found that this divide is not inherently due to SES, but rather to the quality of communication young children experience, even within a low-income sample (Cartmill et al., 2013; Hirsh-Pasek et al., 2015; McGillion et al., 2013). This huge variability in how often children are engaged in fluid and connected parent–child interactions at home puts children on an unequal footing even before they enter school doors.

High-quality interventions—both in and out of school—might at least partially remediate this language gap. Some efforts focus on improving the home language environment (Suskind et al., 2015); however, although about 80% of preschool and school-age children's waking time is spent outside of school, in homes and communities, much of the existing intervention work has focused predominantly on classroom settings. Data suggest that language support through caretakers in more formal settings, such as center-based childcare, can help to buffer against the impact of poor language input in the home (Vernon-Feagans & Bratsch-Hines, 2013). Current efforts in schools, however, have been within a culture of high-stakes testing, with teachers reporting "unintentional and possibly negative consequences" for what and how they are teaching in their classrooms (Sunderman, Tracey, Kim, & Orfield, 2004, p. 3). The pressures have translated into decreases in play time and increases in time spent preparing for or taking tests, even in kindergarten classrooms (Miller & Almon, 2009).

While attempting to raise scores on academic measures, policies have insufficiently addressed children's educational needs: test scores continue to reflect low international rankings for the United States (Organisation for Economic Co-operation and Development, 2012), and skills untapped by those measures may also be suffering. Much of classroom time is spent on direct instruction, often dominated by worksheets, rote memorization, and drills of skills without the promotion of meaningful reflection and understanding (Hirsh-Pasek & Golinkoff, 2011). This problem applies to language development, among other domains. For example, among teachers using a scripted literacy curriculum, only 8% used high-quality language learning strategies, while low-quality strategies were used by 40% of teachers (Justice, Mashburn, Hamre, & Pianta, 2008). High-quality strategies included the teacher asking many open-ended questions, repeating or extending students' responses, and using abstract vocabulary, among others. In contrast, low-quality strategies included a majority of close-ended questions, teacher-controlled conversations, and the infrequent use of advanced language. In similar work, when Neuman and Dwyer (2009) reviewed how vocabulary is taught in preschool, they concluded that "strategies that introduce young children to new words and entice them to engage in meaningful contexts through semantically related activities are much needed" (p. 384).

Across the board, whether in formal or informal learning situations, there is a strong need to identify actionable strategies to increase the language richness of children's environments, and this is best accomplished by the translation of knowledge from the languages sciences. In that vein, we have extracted six evidence-based principles of language development from the vast literature on language learning (see Table 1). These six principles focus on frequency, interest, contingency, meaningfulness, diversity, and reciprocity. Each principle is supported by the re-

Table 1
Six Principles of Language Development

Principle	Definition
Frequency	Children learn what they hear the most.
Interest	Children learn words for things and events that interest them.
Contingency	Interactive and responsive environments build language learning.
Meaningfulness	Children learn best in meaningful contexts.
Diversity	Children need to hear diverse examples of words and language structures.
Reciprocity	Vocabulary, grammatical, and narrative development are reciprocal processes.

search literature, and the six principles work in tandem, often overlapping with each other in real-life scenarios. The principles are designed to apply to all learners in some fashion—regardless of age, SES, English language learner status, or other factors—because the variables that influence learning and retention apply broadly. We have presented the principles in academic circles (Harris, Golinkoff, & Hirsh-Pasek, 2011; Konishi, Kanero, Freeman, Golinkoff, & Hirsh-Pasek, 2014) and have begun to use them to inform curricular design (Dickinson et al., 2016; Hadley, Dickinson, Hirsh-Pasek, Golinkoff, & Nesbitt, 2015; Hassinger-Das et al., 2015; Toub, Dore, et al., 2016; Toub, Hassinger-Das, Nesbitt, et al., 2016; Weisberg et al., 2015).

The Read–Play–Learn (RPL) project was a series of studies funded by the Institute for Education Sciences to promote vocabulary development in low-income monolingual and bilingual preschoolers, ages 3 to 5, in the Southern and Mid-Atlantic regions of the United States (Dickinson et al., 2016; Hadley et al., 2015; Toub, Hassinger-Das, Nesbitt, et al., 2016; Weisberg et al., 2015). RPL was the initial testing ground for the application of our six principles to a real-world context. Our intervention was informed by findings from the previous research covered in this review, identifying the most effective methods for spurring language development. In the context of book readings, adults introduced children to new words by providing child-friendly definitions and meaningful gestures, pointing to relevant pictures, and inviting children to say the words. Adults then facilitated play activities to further support word learning. In each phase of the project, children successfully learned the taught words. Here, after describing each of the six principles, we use RPL as an example to illuminate how the rich body of language science data can be applied to help "language-ize" home and classroom environments to improve language learning trajectories for young children.

Six Principles for Language Development

Frequency: Children Learn What They Hear Most

Children's vocabularies and their early language comprehension and verbal processing speed are associated with the quantity—and quality—of words they hear early in life (Hoff, 2006; Weisleder & Fernald, 2013). Even as young as 8 months old, infants start to learn how to carve out words from the stream of speech in their environments. Through statistical learning, infants figure out the probability that syllables follow one another (Saffran, Aslin, & Newport, 1996). When infants hear a phrase like "prettybaby," for example, over time they can note that "pre" and "tty" are statistically more likely to go together than "tty" and "ba." This helps them to extract word units. Infants must hear a sufficient amount of language input to segment the speech stream; specifically, infants' ability to identify new words is related to the frequency of those words appearing in their environment (Hurtado, Marchman, & Fernald, 2008; Huttenlocher, Haight, Bryk, Seltzer, & Lyons, 1991). Additionally, the more speech infants hear, the faster they can process language (Fernald, Marchman, & Weisleder, 2013; Weisleder & Fernald, 2013) and the more readily they can learn new words (Weisleder & Fernald, 2013). For example, by the time a child has figured out the first few words of a conversation, she might have missed the rest of the speaker's sentence. Processing speed differences of just hundreds of milliseconds impact language uptake. However, as Hart and Risley (1995) showed, children hear vastly different amounts of language depending on their socioeconomic background, and thus both processing speed and word knowledge are negatively affected for children from disadvantaged backgrounds (Fernald et al., 2013).

Research with bilingual children shows that the frequency principle applies to both languages. One study (Place & Hoff, 2011) used a parental diary method to document the blocks of time in which bilingual 2-year-old children were exposed to English only, Spanish only, or both English and Spanish. The researchers found that children's English vocabulary and grammar scores correlated positively with the proportion of English-only exposure and negatively with the proportion of Spanish-only exposure. The children's Spanish language scores were also positively related to their Spanish-only exposure and negatively related to their English-only exposure. These findings demonstrate the importance of frequently exposing children to each of the languages they are learn-

ing, though time management is more complicated when multiple languages are involved.

Increasing the frequency of language exposure is a focus of many school-based interventions. For example, Sénéchal (1997) found that children did not make gains on receptive or expressive vocabulary knowledge after words were presented in one book reading, but children did make gains after being exposed to words through three readings. Thus, frequency of repetition was predictive of vocabulary outcomes. Increasing the frequency of word exposure is one clear, actionable strategy that can be implemented easily to facilitate language development.

Interest: Children Learn Words for Things and Events That Interest Them

Children make word-to-world mappings to learn new words. Attending to the same interesting action or event in the world as their parent or caregiver—joint attention—is critical for children's language development (Adamson, Bakeman, Deckner, & Nelson, 2014). Beginning around 6 months of age, infants connect objects to labels as a result of their mothers' gestures to the objects (Matatyaho-Bullaro, Gogate, Mason, Cadavid, & Abdel-Mottaleb, 2014). Adults also often follow children's interests by noticing what children are focused on and providing related commentary (Bloom, 1993). This is a good tactic, as very young children are more likely to learn words for things that *they* find interesting and perceptually salient (Hollich et al., 2000). In fact, children learn better when their parent follows their interest than when the parent tries to get the child to shift focus to the parent's goal (Dunham & Dunham, 1995).

Shared activities—such as book reading—provide prime opportunities for adults to capitalize on children's interest to support a learning goal. For example, duration of book reading and joint attention between mothers and their 9-month-olds significantly predicted children's word knowledge at 34 months of age (Farrant & Zubrick, 2012). Similarly, Hassinger-Das and colleagues (2016) used book reading plus a board game to study how a game affects 4-year-olds' word learning. Although all children experienced two readings, a game, and an equal amount of word review, children who experienced the review embedded in the board game learned more target words than children for whom the review was separate from the game. The research shows that introducing language content through activities that spark children's interest leads to improved learning.

Contingency: Interactive and Responsive Environments Build Language Learning

Language development thrives when children engage in exchanges with adults that are contingent and responsive to their nonverbal and conversational attempts. Responsive parenting is a potent predictor of children's later language, cognitive, and social development (Shonkoff & Phillips, 2000). Imagine that a toddler at the playground points and says, "Slide!" His parent also points and replies, "Yes, that's a slide! Remember the waterslide you used at the pool yesterday?" In this episode of joint attention, the parent's response is temporally and meaningfully contingent on what the child just said. Research demonstrates that this is a potent combination for language learning (McGillion et al., 2013). The role of contingency for language development is well established in the literature (Cartmill et al., 2013; Goldin-Meadow, 2015; Tamis-LeMonda, Kuchirko, & Song, 2014). Contingent verbal and nonverbal interactions between mothers and their toddlers at 2 years of age accounted for 27% of the variance in children's expressive vocabulary one year later (Hirsh-Pasek et al., 2015). These interactions predicted vocabulary over and above general maternal sensitivity and mothers' words per minute.

Research has also demonstrated the opposite: when children are exposed to words in noncontingent contexts, they do not learn as effectively. Kuhl, Tsao, and Liu (2003), for example, studied whether native English-speaking 9-month-olds would retain their ability to discriminate between Mandarin phonemes in the presence of a live model. Mandarin phonemes were only retained through live social interaction; infants who had audio-only or TV exposure to the same Mandarin speaker could no longer discriminate between those phonemes. Similar findings are apparent in work by Roseberry, Hirsh-Pasek, and Golinkoff (2014), who examined verb learning with 24- to 30-month-old children in live social interaction, socially contingent video, or noncontingent video conditions. Only the children in the live social interaction and socially contin-

gent video conditions learned the new verbs. These results and those from the Kuhl et al. (2003) study suggest that socially contingent interactions are optimal for language learning.

Play offers a prime opportunity to build on contingent interactions for the purposes of language learning, both in the classroom and in the home. An especially good setting for vocabulary growth is guided play, which combines the enjoyable nature of free play with adult support for a specific learning goal (Weisberg, Hirsh-Pasek, Golinkoff, Kittredge, & Klahr, 2016). Back-and-forth interactions between adults and children are easily incorporated into guided play, with adults joining children and playing along. Similar play-inspired activities with contingent adult-child interactions are central to the Montessori educational approach, which has been shown to be more effective than other approaches for content areas such as language learning (Lillard & Else-Quest, 2006; Lillard, 2013). By harnessing the power of contingent interactions, educators and parents alike can support language development.

Meaningfulness: Children Learn Best in Meaningful Contexts

Much of what often happens in early childhood settings is based more on making *things* than on making *meaning* (Christakis, 2016). Christakis offers the example of the common arts and crafts activity around Thanksgiving in which preschoolers make a turkey figure out of a tracing of their hand. She argues that teachers could provide a more meaningful experience by instead examining turkey feathers, talking about eggs, or having a farmer come to the class. In a similar vein, presenting new vocabulary in a way that involves highlighting connections between new words and concepts and vocabulary that children already have makes words meaningful for children. Without that sort of meaningful connection, a new word is isolated and of less discernible value for communication. Many adults recall memorizing stand-alone tidbits of information that are quickly forgotten, such as the arcane vocabulary words tested on the SAT.

In contrast, deep and sustainable learning often involves thinking about similarities, differences, or more abstract concepts relating to interconnected ideas (Hadley et al., 2015; Shuell, 1990). There is a compatible argument supported by evidence in the memory literature that semantically meaningful contexts facilitate better comprehension and recall (Bransford & Johnson, 1972). In line with such reasoning, when school-age children were presented with sets of sentences, children remembered them better when they were part of a meaningful and coherent narrative than when the same sentences were presented in an incoherent order (Kapikian & Briscoe, 2012). Even without a narrative storyline, however, individual words can be meaningfully related, such as through categories (e.g., *Blue Jays* and *Robins* are types of *birds*). Neuman, Newman, and Dwyer (2011) found that preschoolers successfully learned vocabulary through the World of Words intervention program, and the authors attributed this success—at least partially—to teachers highlighting the categorical relations between words. They also presented preschoolers with a novel word and its associated category, such as, "This is a vice. It's a tool," and they found that children were able to correctly answer questions about these new words, such as "Can you use these to make things?" Finding connections between new information and prior knowledge supports the memory process (Brod, Werkle-Bergner, & Shing, 2013).

Meaningfulness can also arise when information is grounded in engaging activities. One example is dialogic book reading, in which an adult helps children link the story to their lives. Dialogic reading increases vocabulary and improves children's narrative and question-asking skills (Zevenbergen, Whitehurst, & Zevenbergen, 2003) compared to book reading where this does not occur. Dialogic reading treats children not just as listeners but as participants in an interactive experience (Mol, Bus, de Jong, & Smeets, 2008). Children are then "constructive" learners who, with adult support, meaningfully elaborate on the new information, improving their language learning (Chi, 2009).

Diversity: Children Need to Hear Diverse Examples of Words and Language Structures

Vocabulary input to children can be described in terms of the number of different words ("types") and in terms of the total number of words ("tokens"), including repetitions. While the frequency principle acknowledges benefits of experiencing multiple tokens of the

same word, the diversity principle emphasizes that children do best when they are exposed to a diverse array of word types. For example, data show that young children who heard a wider range of vocabulary from their mothers showed faster growth in productive vocabulary than children whose mothers used fewer word types (Pan, Rowe, Singer, & Snow, 2005).

A second element of the diversity principle highlights the benefits of exposure to a varied set of exemplars that are described by the same word. If "house," for example, is only used to label a child's own home, how would the child learn that the neighbor has his house, too, and that even birds have houses? Equipped with different exemplars, children better understand overarching concepts, such as inclusion and exclusion criteria that dictate category membership (Perry, Samuelson, Malloy, & Schiffer, 2010), and they are less likely to misinterpret words.

The diversity principle is also reflected in the benefits children receive when exposed to different speakers of the same language. Data from research with Spanish-English bilingual toddlers, for example, illustrate that children who are exposed to English through a larger number of conversational partners have greater English language gains (Place & Hoff, 2011). When the researchers looked at the percentage of *native* English conversational partners during the periods of time in which the toddlers were exposed to English only, that percentage was significantly correlated with the toddlers' English vocabulary scores. These findings suggest that it may be the diversity of *native* speakers that is most beneficial for children's vocabulary growth (Konishi et al., 2014; Place & Hoff, 2011).

Diversity can also be considered as variation in the syntactic context in which vocabulary words are presented. Naigles (1996) found that exposure to multiple syntactic frames facilitated young children's verb learning; children saw a video depicting two actions and heard a novel verb first in one syntactic frame (e.g., "The duck is sebbing the frog") and then in a different syntactic frame (e.g., "The duck is sebbing," or "The frog is sebbing"), and they interpreted the word differently based on the combination of frames they heard. These findings relate to the reciprocity principle, as described next.

Overall, the diversity principle recommends variability in vocabulary, speakers, and syntax. Research suggests that there are some activities that tend to support more diverse language and could be leveraged in applied settings. For example, a recent study by Montag, Jones, and Smith (2015) examined vocabulary diversity in picture books and in natural child-directed speech. After compiling a corpus of 100 picture books for use with neonates to 60-month-olds, these researchers randomly sampled sections of narrative to count the number of unique word types in each book as well as in contiguous child-directed speech. Significantly more unique words were found in the picture books than in the natural speech samples, suggesting that one possible strategy for increasing vocabulary diversity is to read age-appropriate books more often. Another practical way to apply the diversity principle is to increase the number of native speakers to whom children are exposed. Different speakers will naturally utilize diverse language structures, vocabulary, and exemplars.

Reciprocity: Vocabulary, Grammatical, and Narrative Development Are Reciprocal Processes

While researchers often focus on only a subset of language skills, such as vocabulary or grammar, an important reality is that these elements do not develop in a vacuum. Vocabulary and grammar development are concurrent and reciprocally related processes (Dionne, Dale, Boivin, & Plomin, 2003). For example, Brown (1957) showed long ago that children could correctly identify a novel word as a verb or a noun based on their understanding of its appearance within a sentence and its grammatical morphemes, such as, "In this picture, you can see *sibbing*" or "In this picture you can see a *sib*." Gleitman (1990) argued that humans often use sentential syntactic structure to help us understand new words, and this is called *syntactic bootstrapping*.

Research shows that children as young as 2 years of age can use syntax not only to identify the part of speech of a new word but also to formulate a strong idea of what the word means (Fisher, Klingler, & Song, 2006). This process was reflected in the data from Naigles (1996) described in the context of the diversity principle, as children interpreted the novel verb's

meaning based on the syntactical presentations that they heard. Other data from Imai and colleagues (2008) show that novel verb-learning is influenced specifically by children's use of the syntactical cues most typical in their native language. In particular, English-speaking 5-year-olds performed better on a novel verb-learning and extension task when the novel verb was accompanied by its arguments (i.e., "Look! She is X-ing it!"), which is most common in English. In contrast, their Japanese-speaking peers performed better when the arguments were dropped (i.e., "Look! X-ing!"), which is more typical in Japanese. The reverse relation of reciprocity between grammar and vocabulary is also apparent in young children, as even 2- to 3-year-old children use *lexical bootstrapping* by relying on their understanding of vocabulary words to glean aspects of language structures (Dionne et al., 2003).

Supporting previous research (Dickinson & Tabors, 2002), the Language and Reading Research Consortium (2015) recently addressed a third dimension of language ability, besides vocabulary and grammar: discourse, which includes comprehension of and ability to make inferences from discourse or text, for example. They reported developmental changes such that the three constructs were undifferentiated in kindergarteners, but by the time children were 8 years old, vocabulary, grammar, and discourse were three separate dimensions of language (Language and Reading Research Consortium, 2015). These findings are compatible with the argument that elements of language are interrelated but distinguishable constructs that develop during childhood.

In practical settings, recognition of the reciprocal relations among aspects of language development can translate into efforts to encourage children to leverage their knowledge in one domain to understand the other. When a new word is the only element of a given sentence with which a child is unfamiliar, the child can use distributional information (e.g., where in the sentence the new word appears), as well as extralinguistic cues, to decipher the new word's meaning. Therefore, adults can present new vocabulary words in meaningful sentences with varying syntactic structures to facilitate children's understanding of a new word. When vocabulary learning takes place within organic conversations, the reciprocity principle is apparent—as are the other principles.

Applying the Six Principles

The research is clear: The six principles of language development provide parents and educators with an effective framework for supporting children's learning. Prior intervention projects have targeted similar evidence-based principles. For example, the World of Words intervention (Neuman et al., 2011) used taxonomic categorization and multimedia tools in ways that leverage principles of meaningfulness and diversity of modes of presentation. In a more comprehensive example, Coyne, Simmons, Kame'enui, and Stoolmiller (2004) explicitly cited a set of evidence-based principles as the rationale for their design of a shared storybook intervention for kindergarteners, and their list overlaps with many of the six principles we present here. However, for their principles, Coyne et al. (2004) specifically drew from research on vocabulary instruction techniques used with children in Grade 3 and above and research on storybook reading methods typically used in prekindergarten through Grade 2. In contrast, our group of six principles is drawn from a broader collection of language sciences research. Prior to RPL, these principles had never before been used as the blueprint for designing a preschool vocabulary intervention that combined book reading and play-based activities.

Initial steps in RPL focused on the selection of words to teach the preschoolers, with a goal of using diverse vocabulary from a range of parts of speech. We deliberately chose words that were at least Level T2 (Biemiller, 2010)—high-priority words that are typically known by advanced students by the end of second grade and not known by at-risk students. This decision ensured that children were unlikely to already know the words or learn them through other experiences during the study. RPL taught up to 16 words per book, while other studies have generally taught four to six words per book (Blewitt, Rump, Shealy, & Cook, 2009; Han, Moore, Vukelich, & Buell, 2010). As noted by Hadley and colleagues (2015), many interventions do not even report the types of words taught; however, our selected words were of

varied form classes, such as nouns, verbs, adjectives, and adverbs.

During the RPL activities, children were exposed to each target word frequently—for example, a total of 12 times each, over the course of multiple weeks, in one phase of the project (Toub, Hassinger-Das, Nesbitt, et al., 2016). Those 12 occurrences were spread across different contexts, including readings of the book, picture vocabulary cards that showed pictures unrelated to the story, and play with figurines, with opportunities to answer comprehension questions. Undoubtedly, these episodes gave children the opportunity to think more deeply about the words and their relation to their own experiences. As children gained experience with words in RPL, activities sometimes invited children to try to recall the words or meanings. Such retrieval practice may have also contributed to children's word learning (Karpicke & Roediger, 2008). The various contexts involving book reading, picture cards, and play also leveraged the reciprocity between vocabulary and grammar, as the conversations included various grammatical cues that could help foster word learning. The contexts also helped to make the words meaningful, whether due to the engaging activities in which they were embedded, the child-friendly definitions that incorporated words children already knew, or the discussions of connections between words and children's lives.

Although much is known about the success of shared book reading techniques—like dialogic reading (Zevenbergen et al., 2003)—little is known about the specific components of book reading approaches that are most effective for language learning. In the first phase of RPL, children took part in one of three reading conditions: Recall, Conceptual, or Didactic (Dickinson et al., 2016; Hassinger-Das et al., 2015). In the Recall condition, no definitions were supplied, and children were prompted to use the new words during a follow-up discussion. In the Conceptual and Didactic conditions, children were given explicit definitions and encouraged to use the words three times: once during book reading and twice during follow-up discussions. All three reading conditions demonstrated comparable and significant vocabulary growth; as such, the three approaches were combined to create the enriched book reading approach used in the later phases of RPL.

Additionally, guided play sessions, in particular, were expressly designed to build on children's interests: the adult provided story-related figurines, and the play often involved adult-scaffolded reenactment of the book's story. Regardless of the theme of the play, the adult would join in, following children's lead. The adult also found organic opportunities to weave vocabulary review into what children were doing, often by reviewing word definitions and giving children opportunities to answer questions about words. During these interactions, the adult could respond in ways that were meaningful and both temporally and semantically contingent on children's conversational bids or nonverbal actions.

Importantly, it was not simply the additional adult-supported review that mattered; not all word review activities were equally effective, as shown by results from a teacher-implemented phase of RPL (Toub, Hassinger-Das, Nesbitt, et al., 2016). In that phase, after target words were introduced in the book reading, teachers reviewed only half of the target words through guided play with children. Teachers reviewed the other half of the target words through a less contingent teacher-led picture card activity. Although real-world intervention research inherently involves less precise experimental control, the two subsets of words were similarly diverse, were all taught through the same book reading process, and were all reviewed with approximately the same frequency. The key difference was in the style of the word review. Our results revealed that children were significantly better at stating word meanings for the words that were reviewed through guided play than for words reviewed in the picture card activity. Guided play better facilitated word learning even though both activities featured retrieval (Karpicke & Roediger, 2008). These findings align with the principles of meaningfulness, contingency, and interest, because word learning was more effectively fostered when children took part in engaging activities in which they used and heard new words during contingent interactions with adults and peers that built on their own interests.

The reciprocity between facets of language development was the focus of a part of RPL that measured children's narrative abilities, in addition to their vocabulary development. For the narrative task, children completed an assess-

ment that asked them to use their own words to retell the stories from the stimulus books. Results showed the reciprocity principle in action: children who experienced our play sessions used more taught vocabulary words in their retellings than children who did not have play sessions but learned the words in other ways. Thus, children who had reviewed the words during play were able to use their newly learned words for the purposes of telling a story (Toub, Hassinger-Das, Schroer, et al., 2016).

In all of these ways, the design of RPL incorporated the principles of frequency, interest, contingency, meaningfulness, diversity, and reciprocity. Across the various phases, both monolingual children and children learning English as a second language showed gains in vocabulary taught through the reading and play activities. Overall, data show that children had significant gains in receptive and expressive knowledge of the taught words, with medium to large effect sizes, depending on the phase of the research. In a teacher-implemented phase (Toub, Hassinger-Das, Nesbitt, et al., 2016), for example, children learned roughly five new target words per unit. This translates to a 15% increase in knowledge of the target words from pretest to posttest, which is a greater percentage than in other studies with book reading and play (Han et al., 2010; Roskos & Burnstein, 2011). In addition, children's gains on the taught words were greater than their gains for words to which they were merely exposed (from the book, but never discussed) or for control words (never present). The effective features of the RPL intervention were strong enough to affect learning even when we taught a relatively large number of new and quite challenging words. Lastly, the effect sizes we have observed in RPL are comparable to (and in some cases more promising than) overall effects reported in meta-analyses of vocabulary-focused interventions (Marulis & Neuman, 2010; Mol, Bus, & de Jong, 2009; Shanahan & Lonigan, 2010).

In sum, focusing on vocabulary development, RPL employed the six principles of language development to improve language outcomes for children. Each phase of the project also incorporated specific design features that helped us to explore the elements of the intervention that might contribute significantly to preschoolers' word learning. Therefore, the previously reported results from the various phases shed additional light on the potential contributions of the six principles. Importantly, the program's focus was on pedagogy, with techniques and strategies that we designed to transfer to other books and play materials. Therefore, RPL reflects the promise of these techniques in real-world application.

Final Thoughts

Development of language skills is related to other growth in the cognitive, social, and emotional domains (Gomes et al., 2007; Hoff, 2013; Leonard et al., 2007; Roben et al., 2013). From early childhood, language skills are crucial first steps toward later spoken and written communication. These communication skills are foundational for acquisition of new facts and ideas in school, the workplace, hobbies, and personal relationships. Therefore, we must translate the science behind language development into practice in our interactions with children to best equip them for these endeavors. The need for additional support for language learning is especially apparent in communities serving children from low-income families, given the language (Hart & Risley, 1995) and other achievement gaps (Jordan & Levine, 2009; Raver, Blair, & Willoughby, 2013; Verdine et al., 2014). We have merely scratched the surface of the theoretical and empirical literature to date, but we distill this rich literature through our six principles: Children learn (a) what they hear the most and (b) words for things that interest them. They learn (c) through contingent and responsive interactions and (d) in contexts in which the word is made meaningful for them. (e) Children need to hear diversity in the language addressed to them, and (f) vocabulary and grammatical development are among reciprocal processes of language development that can be utilized to facilitate one another.

Part of the power of these interrelated principles lies in their practical implications for everyday life. Abstracted from the literature on language learning, the principles transform complex data sets into "edible science"—digestible, accessible, and meaningful—for researchers, educators, and parents alike. Future research could examine the relative strength of each individual principle, to the extent that they can be isolated; however, for the purposes of application, we can take advantage of the power of the overlaps and interrelations among the

principles to best support children's language learning. Adults can implement principle-based strategies to make storybook time and playtime both enjoyable and educational. Even interactions outside of particular child-focused activities offer opportunities to support language learning. For example, a study was conducted in supermarkets to examine how shoppers' conversations with their children were affected by simple signs that were placed around the store (Ridge, Weisberg, Ilgaz, Hirsh-Pasek, & Golinkoff, 2015). These signs suggested conversational prompts about relevant topics, such as different kinds of apples. After the signs were placed, there was greater quantity and quality of talk between adult shoppers and their children. Such findings illustrate that opportunities for language support abound not just in classrooms, but also in communities at large. RPL too, demonstrates the efficacy of these principles in action. Focusing on vocabulary development, we used frequent exposures to diverse words within meaningful sentences as well as contingent, playful interactions that built on children's interest to teach new words. However, it is important to note that the RPL intervention is simply a starting point.

There are a variety of challenges communities will face as we work to translate the science behind these six principles into practice. One challenge for both researchers and caregivers will be in identifying the conditions under which specific principle-based strategies are effective in both school settings and beyond. Even in situations in which principle-based strategies are successful, insufficient training of teachers, parents, and other stakeholders could be a barrier to effective implementation and scale-up. In RPL, classroom teachers often had difficulty juggling both the vocabulary review strategies and the guided play techniques we asked them to use during the play sessions (Toub et al., 2015). Some teachers were not comfortable with or did not enjoy joining children in the play with figurines or adopting the role of a character and taking on the character's voice. For some teachers, such approaches are not only unfamiliar but also might conflict with their formal training. A logistical barrier to implementing these techniques is the preparation time necessary to help teachers embrace them effectively. Even with sufficient time, however, there might also be well-intentioned resistance if stakeholders (e.g., parents, teachers, administrators) have been heavily embedded in the culture of a (false) play versus learning dichotomy (Hirsh-Pasek & Golinkoff, 2011).

To address some of these concerns in our current intervention work building on the RPL project, we are developing additional professional development materials to express the underlying rationale behind our approach. We are also creating a wider variety of play-based tools from which teachers can choose for supporting vocabulary learning (Toub, Dore, et al., 2016). A similar approach could be taken to demonstrate to parents and caregivers how to masterfully weave together play and vocabulary learning and to shift cultural beliefs among the broader community members regarding the role of play in learning. However, we are not suggesting that there is only one way to reach parents and caregivers; disparate levels of literacy and other factors do not make for an easy fix. Even so, stakeholder buy-in is essential, given the limited resources available in both formal and informal educational settings. What else has to shift within classroom settings to allow the time and space for these evidence-based techniques for language support? How can communities help to support teachers in making those shifts?

As the science of learning further enhances our understanding of language development and these six principles, new insights will continue to inform practice. Many aspects of these principles are applicable to learning across domains. For example, principles of meaningfulness, interest, and contingency are reflected in the four broad pillars of learning culled from the science of learning literature by Hirsh-Pasek and colleagues (2015): Children and adults learn best (a) when they are active as opposed to passive, (b) when they are engaged and not distracted, (c) when information is presented in a personally meaningful way, and (d) when the learning is socially interactive and contingent. Future research will help elucidate how the principles intersect with these broader pillars and potentially also operate in different domains. In the meantime, through conscious consideration of these six principles, educators, policymakers, parents, and other stakeholders can increase children's language knowledge both in and out of school, which can have a domino effect on development in other domains.

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