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Toward an ecobehavioral model of early language development

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ABSTRACT

Language development is an important milestone in early childhood that has implications for later achievement. Although a variety of contemporary models have been offered to describe the process of language acquisition, ecobehavioral models provide descriptive and actionable information on both the causal mechanisms of behavior change and development, as well as variables of influence (e.g., settings, environment, policies). Grounded within sociolinguistic theory and empirical literature, we propose and describe an ecobehavioral model of language development that assumes language is learned through the opportunities afforded by caregiver–child interactions. Functional variables of (a) caregiver knowledge, beliefs, and behavior, (b) environmental components and resource availability, and (c) policies and practices are further described as increasingly distal influences on the timing, frequency, and quality of these interactions. Implications and future directions are discussed.

Acquiring language competence is a foundational event in every young child's life. It provides a basis for not only engaging in social interactions that nurture ongoing development and exploration, but also for learning from the world around them. Language competence is also instrumental in acquisition of later, similarly essential, skills, such as literacy (Fernald & Weisleder, 2011; Hammer, Farkas, & Maczuga, 2010; Kendeou, van den Broek, White, & Lynch, 2009; Snow, Burns, & Griffin, 1998). Thus, both for its own sake and for its role in acquisition of other essential developmental competencies, the early and ongoing development of language competence is of interest to many, including parents, caregivers, practitioners, policy makers, and researchers.

While there have been numerous theoretical and empirical analyses of language development, foundational studies by Betty Hart and Todd Risley have been influential in the contemporary work on the importance of early language experiences for development. In particular, Hart and Risley (1995) found significant disparities in early language development across levels of socioeconomic status (SES). Later coined "the word gap," they presented correlational evidence that rates of adult talk directed to children and adult-child interactions were associated with differences in the observed language skills of young children (Cartmill, 2016; Crow & Leary, 2015; Rowe, Suskind, & Hoff, 2013). This work has been robustly replicated and extended in recent years, with consistent links to ecological and interbehavioral variables associated with SES (e.g., Fernald, Marchman, & Weisleder, 2013; Pace, Luo, Hirsh-Pasek, & Golinkoff, 2017; Rowe, 2012). Through a pragmatic approach that links social-environmental factors to child outcomes (Biglan & Hayes, 1996), this large and accelerating body of conceptual, theoretical, and empirical research on the word gap is documenting disparities, and in turn identifying correlates and possible causes, evaluating prevention and early intervention efforts, and considering issues in broad-scale implementation of empirically-supported resources to reduce these disparities (e.g., Greenwood et al., 2017; Hindman, Wasik, & Snell, 2016; Suskind et al., 2013). This work is conceptually and analytically similar to the analysis of social determinants of healthy child development generally (World Health Organization, 2018a, 2018b) and to the treatment of early language development as a primary public health outcome of interest (Crow & Leary, 2015). The analysis of social determinants affords the opportunity to significantly extend and increase the power of models for describing community-level outcomes, like the word gap, and for planning and evaluating efforts to address these disparities.

1. Importance of an ecobehavioral model

The push for prevention and early intervention of early language disparities focuses on everyday factors affecting young children's development. How can we better understand important variables

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affecting development and growth *and* develop new ways to marshal these resources to optimize outcomes?

Many contemporary models of early language development emphasize a variety of structural variables, including time (Bronfenbrenner, 2001; Pruden, Hirsh-Pasek, & Golinkoff, 2006; Sameroff, 2009), cognitive processes (Hoff, 2005; Kuhl, 2010), and a combination of cognitive and experiential factors (Hollich et al., 2000; Tomasello, 2003; Weisleder & Fernald, 2013). While these models are broadly descriptive and generally consistent with developmental and descriptive data, to the extent that explanatory factors are fixed, inaccessible, or immutable, these models provide little basis for action (Biglan & Hayes, 1996). By contrast, models that include functional variables (e.g., ecobehavioral models) are more likely to provide actionable information on causal mechanisms–information that can be used for analysis, prevention, and intervention. As a result, models of functional variables provide evidence that can extend theory, practice, and policy in ways that account for and change observed outcomes in young children.

Ecobehavioral models provide advantages in both identifying descriptive relations between features of the physical and social environment that affect the developmental course *and* serving as the foundation for design and evaluation of efforts to control these relations. These models describe "covariation of and dependencies between behavior and its ecological contexts, both past and present" (Greenwood, Carta, & Atwater, 1991, p. 60) in ways that produce evidence of functional relations between the target behavior and environmental events and/or behaviors of individuals. In many ways similar to Bronfenbrenner's ecological (1979) and later bioecological (2001) theory of child development, ecobehavioral models examine factors that differ in proximity or specificity in their contribution to a target behavior. However, where Bronfenbrenner's model is largely descriptive and heuristic about what influences child outcomes, an ecobehavioral model aims to establish bidirectional causal mechanisms between an array of factors that ultimately control rates of a target behavior (Greenwood et al., 2017, 1991; Rogers-Warren, 1977). Thus, in most instances, ecobehavioral models assume interactions between the child and others or the child and the physical environment produce learning opportunities, while more distal factors affect other features such as the rate or quality of these interactions (Carta et al., 2001; Carta, Greenwood, & Robinson, 1986; Greenwood et al., 1991; Kamps, Leonard, Dugan, Boland, & Greenwood, 1991; Patterson, 1982; Rogers-Warren, 1977).

Within the fields of education and child development, ecobehavioral analyses have been applied to the analysis of social interaction in early education settings (Odom, Peterson, McConnell, & Ostrosky, 1990) and to the examination of factors affecting academic achievement in elementary classrooms (Greenwood et al., 1991). More recently, these analyses have been used in schools utilizing a response to intervention (RTI) model to create an observational tool that measures both "ecological" and "behavioral" events as they change over time (Greenwood & Kim, 2012).

An ecobehavioral model for early language development can be distinguished from other approaches in at least four ways. First, such a model focuses explicitly on causal and functional relations, with the notion that causal variables are malleable (i.e., can be changed or manipulated through some form of direct intervention) and functional (i.e., associated directly with change in a second variable). Second, ecobehavioral models include only intervening variables (i.e., variables that can be operationalized, observed, and/or measured) and not more hypothetical constructs (MacCorquodale & Meehl, 1948), leading to more parsimonious descriptions of language acquisition. Third, ecobehavioral models articulate a "pathway" of causal relations, demonstrating how manipulation of distal variables interact with more proximal variables to produce learning. For instance, policies may increase funding for staff and resources that in turn support caregivers' interactions with their children. In this way, more distal factors like policies or access to skilled staff and interventions help change caregiver–child experiences that, in turn, are the more proximal and immediate determinants of children's language. Finally, because of the established pathways, ecobehavioral models provide a clear roadmap for analysis, intervention design, and communication between research and practice. As a result, these models may (a) afford the opportunity to assess effects of small or large sets of independent variables (e.g., setting, events, schedules, or policies) that can range substantially in their temporal and functional proximity to the behavior of interest, (b) support the translation of research to practice, and (c) become a base for multi-level interventions (Rogers-Warren & Warren, 1977).

2. The proposed ecobehavioral model of language development

Based on the importance of language development and the availability of ecobehavioral frameworks to investigate factors that influence and drive behavior change, the purpose of this paper is to propose an ecobehavioral model of language development that complements and provides a conceptual basis for further extending descriptive and intervention research. This proposed model pays particular attention to ways causal mechanisms of learning and development are embedded within interactions with caregivers,[1] but also ways more distal variables – caregiver knowledge, beliefs, and behavior; environmental components and resource availability; and policies and practices – influence the frequency, quality, and effect of these interactions. The model proposed here is an effort to further articulate Hart and Risley's analyses,[2] assuming that simply hearing caregivers talk does not cause language development in isolation. Rather, identifiable variables in caregivers' behavior, resources, and the policies of communities in which they live influence rates of caregiver–child interactions and, as a result, differentially affect child language competence. We argue that, by using this model, investigators and community partners have the potential to create improved and holistic policies, practices, and interventions to maximize language development for all children.

Like Bronfenbrenner (2001) and other ecological models, we purpose a model with the developing child at the center and development influenced by a concentric set of factors (see Fig. 1). Unlike other models (e.g., universal grammar), however, this figure suggests language learning occurs within caregiver–child interactions and that these interactions, in and of themselves, serve as the "engines of development" or proximal processes (Bronfenbrenner & Evans, 2000, p. 118). Moving outwards from the caregiver–child interaction, we first attend to caregiver beliefs and knowledge, or the general variables that guide, influence, or evoke caregiver behaviors associated with the amount and type of interaction with children. Next, we analyze effects of large and small elements of the physical and social environments. At the outermost level, most distal to the child and language learning, we place policies and the formal practices they regulate that in turn create, sustain, or manage the more proximal factors. Finally, our model incorporates time, as it acknowledges the cumulative effects of caregiver–child interactions, as well as the potential for variation in the influence each factor exerts as a child grows and develops.

[1] We use the term "caregiver" broadly to include parents, other adults (including childcare or early education staff), and in some instances, other children. Regardless of relation to the child, the defining feature of this class of "caregivers" is that they spend time in proximity to, and interacting with, a young child.

[2] We acknowledge this further articulation is both entirely consistent with both Hart and Risley's (1995) approach and their broader work on child development.

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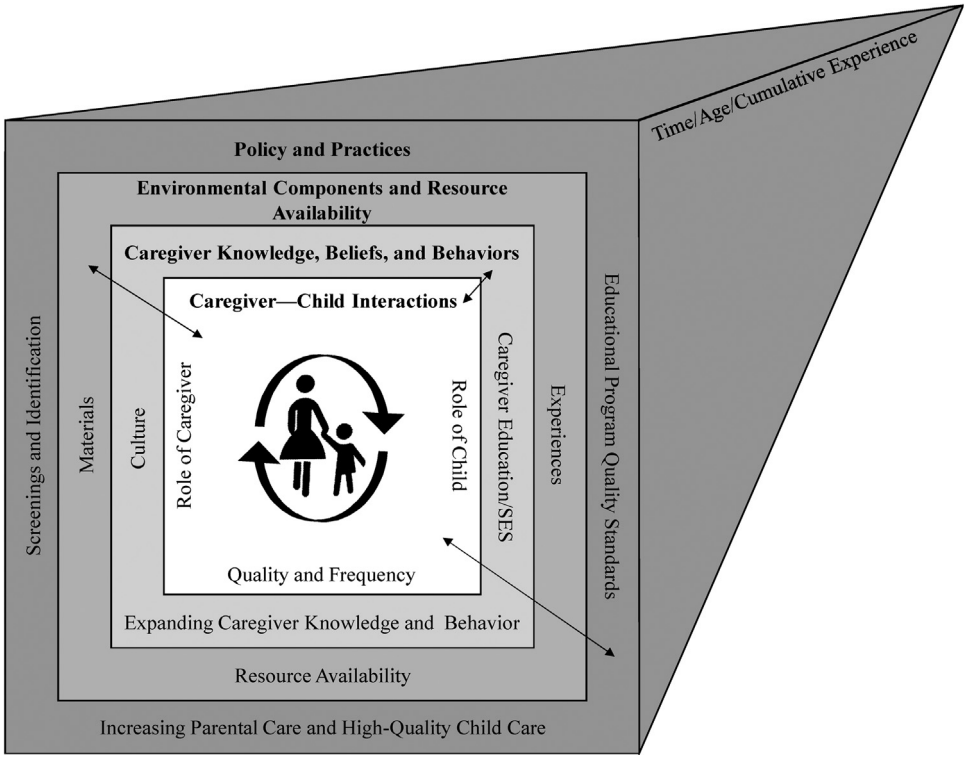

Fig. 1. An ecobehavioral model of language development which views caregiver–child interactions as the mechanism for language learning. The model aims to conceptualize the influential levels that can shape the quantity and quality of caregiver–child interactions. The arrows across the different levels depict the bi-directional nature of the levels.

3. Assumptions within the proposed model

This ecobehavioral model makes four assumptions: (a) language is acquired through learning; (b) causal mechanisms associated with this learning are, in large part, embedded in interactions with caregivers; (c) interactions have varying quality that affects the rate of this learning; and (d) distal-level factors influence the occurrence of these interactions and, in turn, the magnitude of language learning. In general, these assumptions reflect broad summaries of theoretical and empirical analysis; each is, in principle, fully falsifiable and thus available for empirical evaluation (Shadish, Cook, & Campbell, 2002). In this instance, they are offered as background for more content-specific analyses that follow.

3.1. Language as learned behavior

First, we advocate for a behavior-analytic learning paradigm embedded within a broader ecological and sociolinguistic perspective for understanding language development. While we recognize complex brain-based processes (Kuhl, 2010) and innate ability for language growth (Chomsky, 2005), the model presented here explicitly focuses on malleable influences of language development and assumes language is learned through experience with, and exposure to, social interactions (Dunst, Lowe, & Bartholomew, 1990; Fernald et al., 2013; Pruden et al., 2006; Warren & Walker, 2005). Pragmatically, we also argue differences in developmental opportunities associated with language learning account for substantial variance in observed language disparities, so these opportunities should be central to our analysis. For individuals most interested in supporting children in developing language skills, particularly when challenges and inequalities in this development arise, it can be argued this approach to language as a learned skill provides a clear avenue for intervention.

3.2. Interactions as the context for learning opportunities

Interactions occur when a caregiver and child communicatively exchange in the context of a shared activity, object, or experience, such that the behavior of one individual "evokes, maintains, or modifies the behavior of another" (Dunst et al., 1990, p. 39). Placing interactions at the center of our model reflects both their conceptual status as the primary and most proximal context for language learning, but also empirical evidence of the relation between caregiver–child interactions and language outcomes (Dunst et al., 1990; Fernald et al., 2013; Hart & Risley, 1995; Hirsh-Pasek et al., 2015). As such, we assume causal features of language learning – antecedents that provide developmentally appropriate *opportunities* that evoke child language production and *responses* from caregivers that reinforce this language – take place within the everyday interactions young children have with caregivers (Bijou & Baer, 1961; Skinner, 1953).

It can be argued further that key features promoting language learning are events that secure the child's attention, evoke some appropriate child response, and lead to caregiver responses that serve to reinforce the child's behavior. Rarely do these three events occur in isolation; rather, they unfold in interlocking ways. For instance, a caregiver's initiation to a child produces a vocal response from the child, which in turn serves as a stimulus for response from the caregiver. This latter caregiver response can serve as both a reinforcing consequence for the first child communicative act and the antecedent for another child communicative response, which in turn evokes caregiver behavior and thus extends the interaction. Importantly, as these interlocking events continue, more learning opportunities are provided to the developing child. This bidirectional interaction (illustrated in Fig. 1) is also transactional; it is often likened to a "serve, return, volley" event, in that the interaction is characterized by a responsive, adaptive, back-and-forth relation in the behavior of the two interactive partners over time

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(Crow & Leary, 2015; Sameroff, 2009). In this way, both the child and caregiver contribute to the content, pace, and direction of interactions that, when synchronous, maximize learning opportunities for the child (Greenwood, Thiemann-Bourque, Walker, Buzhardt, & Gilkerson, 2011; Pruden et al., 2006; Sameroff, 2009; Zauche, Thul, Mahoney, & Stapel-Wax, 2016; Zimmerman et al., 2009).

3.3. Interactions vary in quality

Any interaction can have the basic features of learning—opportunities to interact (i.e., antecedents) and subsequent caregiver responses (i.e., functional consequences). Only some interactions, however, will incorporate features more encouraging of, informative for, and responsive to the child; that is, their inclusion promotes interactions and causes more meaningful change in language learning (Hart & Risley, 1995). Some language researchers have argued these features, termed "quality" of caregiver–child interaction, are more central to language learning than the quantity of those interactions *per se* (Golinkoff, Hoff, Rowe, Tamis-LeMonda, & Hirsh-Pasek, 2018; Hirsh-Pasek et al., 2015; Pianta & Hamre, 2009; Snow, 1977).

Definitions of quality in caregiver–child language interaction research vary somewhat, but at the core investigators define quality by an interaction's behaviors and transactional features. These can include diversity and complexity of words and grammar, sensitive parenting (i.e., "a global description of a caregiver's provision of warm, responsive, and stimulating engagement with his or her child," (Hirsh-Pasek et al., 2015, p. 2)), joint attention, fluency and connectedness, or routines and rituals (Hirsh-Pasek et al., 2015). The model presented here assumes quality dimensions like these are instrumental to language learning because they produce more frequent and longer interactions, thus producing more *opportunities* for interaction and language learning. While further analysis of these quality dimensions is outside the scope of the current paper, we look forward to theoretical and empirical developments that account for ways that qualitative or quantitative features account for significant variance in language outcomes.

3.4. Distal factors as influencers

Finally, we assume child-caregiver interactions are necessary *and* sufficient to cause the acquisition of language, while other macro-level factors that differ in proximity – policy, environment, caregiver knowledge of development – are neither necessary *nor* sufficient to cause language development alone but influence the magnitude of development by setting the occasion for interactions to occur. That is, these factors control access to, rates of, and effects of children's exposure to opportunities for interaction with caregivers (i.e., antecedents), as well as functional consequences provided by caregivers. For instance, features of the physical environment (e.g. age-appropriate picture books that prompt caregiver suggestions for child behavior), do not, in and of themselves, provide opportunities nor consequences for children's emerging language. Rather, these variables set into motion caregiver behaviors that in turn set the stage for child language and the interactions that produce the tightly coordinated events that result in learning.

Equipped with an understanding of the four assumptions that set an overarching foundation for our proposed model, we shift the focus to each level of the model providing more in-depth descriptions and implications.

4. Level I: caregiver–child interaction

4.1. Definition and roles

Within interactions with caregivers, and particularly when these interactions occur frequently, children are afforded opportunities to experience and expand language, a key ingredient for language learning (Hart & Risley, 1995). Before moving further, it is critical to refine what we mean by an interaction to set the stage for a discussion of both empirical evidence for and implications of this core component. The following example illustrates a potential and ideal way in which a long, sequenced interaction can unfold, with a child's non-verbal and verbal behaviors responded to by a caregiver:

Child:	[pointing to an airplane in the sky]
Caregiver:	*It's an airplane. What is it doing?*
Child:	*Plane fly! Go zoom.*
Caregiver:	*Zoom, zoom, zoom! It's flying high.*
Child:	*Plane fly high.*
Caregiver:	*That's right, it's high in the sky. Remember when we went on a plane to see grandma?*
Child:	*I go gamma [Grandma].*
Caregiver:	*Uh-huh, we went to grandma's house.*

It is helpful to break down this illustration in terms of the (a) opportunities for interaction or antecedents provided by the caregiver, (b) behaviors of the child, and (c) functional consequences or caregiver responses to illustrate the interaction's causal nature. First, the child pointed to the sky (i.e., the behavior), initiating the opportunity for a shared interaction regarding a plane. The caregiver then responded to and likely reinforced (i.e., the functional consequence) the child's communicative act by first providing a verbal label. When asking a related question (i.e., "What is it doing?"), this caregiver response also set the occasion for additional communicative behavior from the child (i.e., another antecedent or opportunity for continued interaction). This caregiver's verbal label and question sustain the interaction, increasing the positive consequences for the young child. Likewise, the child's behavior, such as "Plane fly! Go zoom!" and "Plane fly high" evokes a caregiver response and contributes to continued interaction. Again, it is the synchrony in the exchange embedded within the bidirectional, extended sequence of communicative behaviors from both the child and caregiver that maximizes the language learning opportunity (Crow & Leary, 2015; Owens, 2001).

4.1.1. Role of the child

Supporting language development requires more than simple exposure, wherein the child is a passive learner absorbing language input (Golinkoff et al., 2018; Hoff, 2006; Kuhl, Tsao, & Liu, 2003; Weisleder & Fernald, 2013). In fact, we know that only overhearing language within naturalistic settings is not predictive of later vocabulary; this lack of association may be the result of a child's attentional focus being unconstrained, caregivers not referencing visually present objects, and/or a lack of timely, positive responses to any child behavior (Shneidman, Arroyo, Levine, & Goldin-Meadow, 2013). Thus, for a child to obtain maximal benefit of the language input around them, the child must become an active participant learning the association between their behavior and the caregiver's response (Dunst et al., 1990). This learning further serves to: promote the child's initiations of and turn-taking within an interaction, increase the direction of their behavior or their attentional focus toward the responsive caregiver, increase the "readability" of their communicative act, and support learning of eventual conversational discourse (Bloom, Rocissano, & Hood, 1976; Dunham & Dunham, 1992; Dunst et al., 1990; Landry, Smith, Swank, & Guttentag, 2008). As the child's communicative repertoire expands, this learning has the added benefit of increasing the opportunities for interaction. It is the child's behavior – a gaze,

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gesture, sound, word, or phrase – that frequently serves to set the occasion for a caregiver to start *or* continue the interaction.

4.1.2. Role of the caregiver

Caregiver behavior is equally important in interactions and involves two functions—providing opportunities (e.g., "Remember when we went on a plane to see grandma?") and reinforcing consequences (e.g., "Zoom, zoom, zoom! It's flying high."). The caregiver can initiate and sustain interactions by noticing and acting on child interests or attention, asking questions, making comments, or providing prompts for behavior (Pianta, Barnett, Burchinal, & Thornburg, 2009). The function of the caregiver behavior here is to provide the *opportunity to interact*. For these opportunities to be most effective, they must evoke a behavior by being challenging (Greenwood, Delquadri, & Hall, 1984), but still within the child's zone of proximal development, that is, what a child can achieve with guidance and support from caregiver (Vygotsky, 1978). This zone of proximal development changes over time, and as the child's language develops, caregiver behavior must also change to create more and different learning opportunities. Likewise, caregivers can reinforce and extend the interaction by recasting, expanding, elaborating, using advanced linguistic models, and adding appropriate focus or content to the interaction (Pianta et al., 2009; Warren, 2015); the caregiver behavior here is the *functional consequence*. In this end, this contingent reinforcement of a child's production, coupled with support and encouragement of new productions through antecedent events, is the base of a child's learning (Shonkoff & Phillips, 2000).

4.2. Frequency and quality of interactions

Abundant research findings provide evidence of relationships between the frequency or dosage of a child's interactions and the child's later language development. Hart and Risley (1995) argued that the number of interactions between a child and a caregiver, a measure they defined as "number of words addressed to the child," may be the most important factor for language learning. More frequent interactions which include both opportunities and functional consequences are not only recommended, but essential to language learning (Hart & Risley, 1995; Hoff, 2006; Warren, 2015). In fact, children who are provided with more opportunities to interact build larger vocabularies and at a faster rate than those with fewer opportunities (Hoff & Naigles, 2002; Huttenlocher, Haight, Bryk, Seltzer, & Lyons, 1991; Weisleder & Fernald, 2013).

While the frequency of interactions, and thus opportunities to learn, is essential, it is not only the number of times per day a child and caregiver interact that matters, but also the features of those frequent interactions that are driving language development.

> Children in social environments that provide them with more communicative interaction, particularly with an engaging and responsive communicative partner, and more adult-produced, child-directed speech, particularly speech that uses a rich vocabulary and complex structure—acquire language more rapidly than children in social environments that provide less of these supports. (Hoff, 2006, p. 72)

Responsive and developmentally rich "high-quality" interactions unfold when a caregiver attributes meaning to a child's attentional focus or signal (such as the child's gaze, gesture, or verbalization), and then interprets and expands this signal (Dunst et al., 1990; Owens, 2001; Warren et al., 2008). Through this exchange, the caregiver builds joint attention, supports beginning reciprocal conversation, and gives some conversation control to the child, all which support language development and communication competence (Warren, 2015). This response to children's attentional focus, in contrast to redirection of attentional focus, has been shown to support receptive and expressive vocabulary development, initiations by the child, and social cooperation (Dodici, Draper, & Peterson, 2003; Landry, Smith, & Swank, 2006; Landry et al., 2008; Parpal & Maccoby, 1985). Responsive interactions have an added benefit of motivating young children to engage with caregivers that exhibit qualities of being responsive and engaged in the child's attentional focus (Landry et al., 2008). In turn, these responsive, quality interactions lead to increased frequency of opportunities for language input and communicative exchanges. Taken together, these findings suggest dosage and quality of interactions are both necessary for understanding acquisition of vocabulary and where intervention efforts should be placed when challenges and inequities arise.

As described, caregivers have an essential role and profound impact on a child's language development (World Health Organization, 2004). This idea has led to a wealth of literature investigating caregiver characteristics such as education, knowledge, skill, and beliefs that may contribute to the quality and quantity of caregiver–child interactions. As we move out from interactions at the core, we argue that characteristics of the caregiver, notably their knowledge and capacity to support language development, have the next greatest impact on a child's opportunities to interact and ultimately, a child's language learning.

5. Level II. Caregiver knowledge, beliefs, and behavior

An individual's knowledge and beliefs can shape their behavior, and changes in these beliefs and knowledge can result in changes in their behavior (Cote & Bornstein, 2000). Specifically, caregivers' knowledge and beliefs can affect the frequency, structure, and quality of their interactions with young children, including how caregivers interpret and respond to children's behavior.

5.1. Relationship between caregiver knowledge and caregiver behaviors

Benasich and Brooks-Gunn (1996) define parental knowledge, as the "parent's understanding of developmental norms and milestones, processes of child development, and familiarity with caregiving skills" (p. 1187). Differences in parental knowledge are associated with differences in parenting behaviors (Benasich & Brooks-Gunn, 1996; Rowe, 2008), which are, in turn, related to differences in child language outcomes (Dollaghan et al., 1999; Donahue, Pearl, & Herzog, 1997; Rowe, 2008). Parents who have an increased knowledge of child development (e.g., order and timing of milestones) tend to have more interactions that facilitate language learning experiences, as they structure the environment to promote development (Benasich & Brooks-Gunn, 1996; Huang, O'Brien Caughy, Genevro, & Miller, 2005; Rowe, 2008). For example, mothers with increased knowledge of child development and play skills are more likely to introduce higher-level play scenarios, appropriately challenging their children (Damast, Tamis-LeMonda, & Bornstein, 1996). By structuring interactions within their child's zone of proximal development (Vygotsky, 1978), caregivers are facilitating learning. Furthermore, caregivers knowledgeable in child development are more likely to increase the quality of their interactions by showing sensitivity, using a greater diversity of words, producing longer utterances, and using less directive speech when compared to caregivers less knowledgeable in child development (Huang et al., 2005; Rowe, 2008).

While the link between caregiver knowledge about child development and caregiver–child interactions is evident, there appear to be several characteristics, such as education or SES and caregiving experience, that predict caregiver knowledge and behavior in ways that are related to child language outcomes. Also, we note

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that much of the evidence is correlational and further research is needed to identify causal mechanisms.

5.2. Predictors of caregiver knowledge and capacity

5.2.1. Caregiver education and SES

It has been widely demonstrated that caregiver education and SES are associated with differences in child language outcomes (Dollaghan et al., 1999; Fernald et al., 2013; Hart & Risley, 1995). Children of parents with more education and higher SES may be exposed to longer utterances, more diverse vocabulary, higher quantity of words, and less directives compared to children coming from lower-SES families; this exposure was related to child vocabulary development (Rowe, 2008). These differences in child vocabulary and SES are already present at 18 months (Fernald et al., 2013). Additionally, children from middle-SES families vocalized over twice as much as compared to children from lower-SES families during play interactions and were also more likely to initiate play interactions (Hammer & Weiss, 1999). Not only can children from lower-SES families be exposed to fewer caregiver-initiated opportunities to interact, but they can also be less likely to initiate interactions themselves, which may limit their opportunities for learning. Similar to caregivers with less education, Tamis-Lemonda, Shannon, and Spellmann (2002) found that adolescent mothers of low-income status tended to underestimate the onset of developmental milestones. This underestimation may reduce the rate and quality of caregiver–child interactions and further result in the caregiver not challenging the child's language competency enough to increase his/her knowledge.

Caregiver education and SES are also related to the nature of the interactions. For example, the complexity and diversity of utterances increases as caregiver educational level increases from high-school to a graduate degree (Huttenlocher, Waterfall, Vasilyeva, Vevea, & Hedges, 2010). As a result, children from middle-SES families may be exposed to greater amount and variety of opportunities to interact and learn than children from low-SES families. Ultimately, these differences in the type of language used within a caregiver–child interaction are associated with differences in child language outcome.

5.2.2. Culture

The environment around the caregiver, such as one's culture, can also affect these interactions. In fact, culture can influence a caregiver's knowledge and beliefs regarding child development and, as a result, affect their behavior (Bornstein et al., 1996; Weber, Fernald, & Diop, 2017). Cultural practices may vary in ways that relate to interactions with young children and these differences may explain, in part, group differences in language outcomes. For example, caregivers in cultures that are more likely to view young children as communicative partners, such as North American caregivers, are also more likely to initiate conversations, even out of sneezes or burps (Snow, 1977). Cultural beliefs can also influence the way caregivers and children engage in certain activities that set the stage for quality interactions. For example, shared book reading has been demonstrated to be positively associated with children's vocabulary outcomes (Foster, Lambert, Abbott-Shim, McCarty, & Franze, 2005; Hindman et al., 2016; Storch & Whitehurst, 2001) and cultural differences have been observed to influence the frequency of this activity. Speaking to culture's influence of the frequency of caregiver–child interactions, Hammer et al. (2010) reported white mothers in their sample read more to their children when compared to Latina mothers. Further, during shared book reading, middle-class white families have been observed to include more questions (Rogoff, Moore, Correa-Chávez, & Dexter, 2015), whereas Latina mothers tended to use the opportunity to talk about moral lessons (Perry, Kay, & Brown, 2008). These differences by culture demonstrate its potential to influence the structure and goal of learning opportunities.

5.3. Expanding caregiver knowledge and behavior

Given the relation between caregiver knowledge and behavior, and consequently the relation between caregiver behaviors and child language outcomes, effective outreach and training programs that increase caregiver knowledge may have concurrent effects on child language learning. For example, caregiver knowledge can mediate the relationship between SES and child-directed speech (Rowe, 2008), suggesting an increase in programs targeting caregiver knowledge may improve the home language environment regardless of SES. By expanding caregiver knowledge and skills related to language outcomes, we can increase the likelihood children will be exposed to quality caregiver–child interactions. Caregiver training programs can be implemented from a variety of different tiers, such as population, community, and child/family (Greenwood et al., 2017), as well as target the different levels of our proposed model (e.g., programs targeting caregiver knowledge and interventions that teach caregivers to embed natural learning opportunities within physical environment). Some current interventions include well-child visits (e.g., population level; Mendelsohn et al., 2011) and "Talking is Teaching: Talk, Read, Sing" launched in cities and communities throughout the United States (e.g., community level; Roblyer & Morris, 2018; Too Small to Fail, 2016). By taking this multilevel approach, parent knowledge and beliefs can be affected in ways that produce greater probability children will be exposed to quality opportunities to interact, thus increasing language ability.

In a later section, we review policy contributions to language learning; several of these policies relate to increasing and leveraging the opportunities from well-child visits to primary health care settings. These visits may also provide an opportunity to affect parents' knowledge and beliefs about their child's development. In Gallup's annual Health and Healthcare Survey in 2010, 70% of Americans felt confident in their doctors' advice, indicating a certain level of respect for the profession (Newport, 2010). Because of this respect, doctors have an opportunity to encourage primary caregivers to act in support of their children's development and specifically language development. One way pediatricians address this is an initiative called *Reach Out and Read* where books are provided to children during well-child visits starting in infancy until the beginning of school (Reach Out and Read, 2014). In addition to providing access to books, this opens an opportunity to increase caregiver knowledge of the importance of engaging in interactions around books to support language development.

Although caregivers with sufficient knowledge and skills can initiate and incorporate opportunities to interact within their natural environment and routines, the structure and composition of the physical environment can help facilitate and increase the likelihood of opportunities to interact, moving more distally from the core interaction.

6. Level III. Environmental components and resource availability

Children acquire language through interactions with their caregiver that are routinely occurring within the context of their environment. Here, we define the environment as the resources – materials and experiences – available to caregiver–child dyads that help facilitate opportunities to interact. In the proposed model, we argue the environment *itself* does not provide opportunities nor consequences that promote language learning, but rather sets the occasion for these interactions. Likewise, children interacting

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with their environment provides opportunities to learn associations between their behavior and caregiver responses. While there are a variety of objects or instances that promote opportunities, behaviors, and functional consequences, such as books, toys, or activities, their function remains the same: to provide caregivers and the child with prompts and topics while engaging in interactions (Rodriguez et al., 2009). The intent of analysis presented here is not to provide an exhaustive list of these materials or activities, but rather to provide an understanding of what and how the physical environment is related to language development with key examples from the literature. It is, however, important to consider how variables affecting accessibility to environmental resources may change a child's course of development. We use SES to illustrate this point following descriptions of materials and experiences.

6.1. Tools for promoting interactions

6.1.1. Materials

A variety of materials in the home can be used by caregivers and children during interactions. This can include educational materials, such as books and toys, or common household items, such as kitchen utensils, pictures, and photographs. More specifically, children's storybooks provide an important and well-researched means for both creating opportunities to interact and promoting specific elements of caregiver–child interactions that have clear benefits to language learning (Dickinson, Griffith, Golinkoff, & Hirsh-Pasek, 2012; Sénéchal, 2012). For example, having a book available in the home has the potential to promote three critical elements in language learning discussed previously: (a) opportunities, as a caregiver asks questions about or comments on the pictures in the book; (b) child behaviors associated with the book that occasion caregiver responses, such as pointing to a picture, verbally labeling a picture, or asking a question about the story; and (c) functional reinforcement by the caregiver contingent on the child's behavior within the book, such as acknowledging a correct behavior or recasting and expanding upon what the child said. In this example, the book provides a meaningful, rich context – or tool – in which caregiver–child interactions can occur. In turn, this promotes language learning for the child.

Books also afford opportunities for joint attention, a necessary piece of an interaction (Akhtar & Gernsbacher, 2007; Dickinson et al., 2012). That is, books allow for a shared attentional focus between the child and their caregiver. Depending on their beliefs and skill, caregivers can engage in responsive and child-directed interactions around books (Bus, 2003). In fact, caregivers have been observed to or taught to engage in a variety of language facilitation techniques, such as asking questions, prompting labeling of pictures, directives, attentional cues, recasting what a child, and expanding on the child's interests, during shared book reading (Anderson-Yockel & Haynes, 1994; Hindman, Skibbe, & Foster, 2014; Martin, 1997). Finally, books provide a medium for learning new, diverse words that connect to the broader world, as the text and/or images may provide exposure to low-frequency words that may not occur in the context of other, everyday interactions (Dickinson et al., 2012; Rodriguez et al., 2009; Sénéchal, 2012). Overall, it has been suggested that while the benefits of books and the shared book reading experience in and of themselves do not predict language learning (Rodriguez et al., 2009; Tomopoulos et al., 2006), they do provide robust means by which features of sustained, quality interactions can unfold.

6.1.2. Experiences

Beyond physical objects, a child's experience within naturally-occurring adaptive routines (e.g., bedtime, mealtime), community outings (e.g., visiting the zoo or museum), and play routines (e.g., singing and lap games) can afford important contexts and opportunities for caregiver–child interactions that promote learning, and, more specifically, language development (Dunst, Raab, & Trivette, 2011; Roberts & Kaiser, 2011; Rodriguez et al., 2009; Snow et al., 1998; Walker, Bigelow, & Harjusola-Webb, 2008; Woods, Kashinath, & Goldstein, 2004). For example, visiting the zoo, museum, bookstore, or library, can provide both the caregiver and child with a variety of different environmental prompts that initiate interactions, create new opportunities for learning, and produce functional consequences. These activities are supported empirically with clear associations to promoting language development (Dunst, Valentine, Raab, & Hamby, 2013; Payne, Whitehurst, & Angell, 1994).

Everyday routines where caregivers engage in conversational exchanges, such as mealtimes and bath time, have also been shown to promote language learning (Rush, 1999) and are, in fact, encouraged as important contexts for interactions (Dunst et al., 2011). In the same vein as materials, these activities further provide contextually-relevant and meaningful settings for social exchanges to occur between caregivers and children. They offer repeated, and sometimes frequent, exposure to activity-specific words and actions (Dunst et al., 2013; Rodriguez et al., 2009). Importantly, these experiences can occur within *any* naturally occurring routine for an individual child, and thus can be accessed and leveraged by all caregivers.

6.2. Resource availability

The availability of these resources – books, toys, and experiences – may be differentially available for children depending on individual circumstances. SES is one possible mediator here: caregivers from low-SES families may engage in fewer interactions with their young children due at least in part to limited access to learning materials, such as toys and books (McCormick & Mason, 1986; Rodriguez et al., 2009; Whitehurst et al., 1994). Both Hart and Risley (1995) and Pungello, Iruka, Dotterer, Mills-Koonce, & Reznick (2009) suggest fewer resources of any kind can reduce the amount of quality interaction opportunities between a caregiver and child, which is at the core of this model. Lack of resources, in turn, has been hypothesized to be part of the slower rate of language development for children from low-SES homes compared to middle- and upper-SES homes (Pungello et al., 2009; Rodriguez et al., 2009). Caregivers from middle-to upper-SES homes may be more likely to have the resources, including time, energy, money, education, finances, and community opportunities, that serve as tools to improve their interactions with the child.

While caregivers may not utilize any or all of environmental contexts, the presence of these resources sets the stage for language-learning and suggests an important area of continued research to understand links between environments and language outcomes (Rodriguez et al., 2009), as well as the need for interventions and practices that provide all families with access to resources. With the support of specific policies from the local to federal level, the potential for these materials and experiences to provide important contexts to language learning can be increasingly realized for all children.

7. Level IV. Policies and practices

Policies and practices are most distal from the individual child in this ecobehavioral model of language development, yet they set the foundation for opportunities that directly influence language learning. For example, policies and practices can create opportunities for caregivers to spend substantial time with their children and reduce time in congregate care settings, by incenting or mandating parental leave during early years (Berger, Hill, & Waldfogel,

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2005; Galtry & Callister, 2005). Similarly, policies can provide all children access to high-quality early education settings (Christina & Goodman, 2005), as well as early intervention services, by requiring school districts to locate children with developmental needs and provide services to help meet these needs. In this model, policies are statements of intent, including formal laws and regulations, funding programs, and other legal requirements related to child development. Practices are activities implemented to meet the requirements of policies. Policies and practices influence expectations and resources for the developing child and his/her family.

7.1. Increasing parental care and high-quality childcare

Parental leave policies are most typically associated with Scandinavian countries where parents are provided salary replacement as well as guarantee of job return on the birth of each child. Such leave policies stabilize and standardize parents' opportunities to devote considerable, focused time to caring and interacting with children during the first year of life. Parental leave policies vary somewhat, but evidence of their relation to child development outcomes is generally strong (Berger et al., 2005; Galtry & Callister, 2005). Future research on parental leave should detail ways in which leave policies, both alone and in combination with other family supports like education and material resources, influence the frequency of interactions and child development outcomes.

Similarly, in political jurisdictions where such parental leaves are not available, policies that make infant and toddler care more readily accessible and of higher quality (e.g., more staff training requirements, lower adult-to-child ratios, stricter safety requirements) ensure young children in non-parental care are still in places where frequent, sensitive, responsive, and developmentally supportive interactions can occur (NICHD Early Child Care Research Network, 2002, 2005). Researchers and policymakers continue to debate relative merits of parental and non-parental care for young children, as efforts continue to increase quality of childcare across wide systems. Policies for parental leave and childcare access and quality are likely to both distally contribute to child language outcomes at the population level.

7.2. Screenings and identification

Throughout infancy and into the preschool years, a variety of early childhood screenings and identification tools, such as developmental screening and well-child visits, evaluate and detect children at risk of developmental delays during critical times of growth and learning, and provide a basis for allocating additional supports to children and families (Mackrides & Ryherd, 2001; Pool & Hourcade, 2011). Identifying these warning signs early increases the likelihood for more opportunities to be available earlier on to address developmental concerns and mitigate delays as much as possible. If concerns are not addressed, meaningful interactions, among other developmentally necessary experiences, may be limited. Screening and early identification can lead to access to intervention services, which in turn help to promote appropriate interactions so the child continues to receive sufficient language input (i.e., Fricke, Bowyer-Crane, Haley, Hulme, & Snowling, 2013; Sawyer & Butler, 1991).

7.2.1. Well-child visits

Visits to pediatricians are frequent during the first years of life due to children's rapid development. During these well-child visits, pediatricians evaluate a child's physical health as well as developmental and behavioral health. These visits are beneficial in helping to prevent illness, tracking a child's growth over time, addressing caregiver's concerns, and identifying developmentally-appropriate milestones (American Academy of Pediatrics, 2017).

The American Academy of Pediatrics (AAP) provides *Bright Futures Guidelines* for monitoring children's health and well-being (American Academy of Pediatrics, 2017). Prior to pediatrician visits, a primary caregiver completes an age-specific questionnaire asking about developmental milestones and the child's well-being. Focusing specifically on language, these visits and questionnaires can help draw attention to communication delays. In a study of 1428 caregivers and children at 12- and 24-month visits, referral rates for additional evaluation by pediatricians increased with use of these tools and assisted in identifying children in need of services (Hix-Small, Marks, Squires, & Nickel, 2007).

7.2.2. Child find initiatives to identify children at-risk

Child language may not develop as expected and required for later successful functioning, potentially due to stable characteristics of the child or caregivers or due to environmental factors. In these instances, early intervention for language development is crucial, as earlier identification and intervention is generally associated with better outcomes (e.g., Koegel, Koegel, Ashbaugh, & Bradshaw, 2014; Moeller, 2000).

The Individuals with Disabilities Education Act (IDEA) is a federal law requiring children aged 0–21 years with disabilities to have access to free appropriate public education and special education services (IDEA, 2004). Included within IDEA is the Child Find mandate that determines each state "must have in effect policies and procedures to ensure that — (i) All children with disabilities residing in the State. . . and children with disabilities attending private schools, regardless of the severity of their disability, and who are in need of special education and related services, are identified, located, and evaluated" (IDEA, 2004, 20 U.S.C. §1412(a)(3)). This requirement extends to all children, starting at birth; as such, this policy provides another resource for finding and serving children with delays as early as possible. Child find initiatives can be, but are not exclusive to, physician visits. Other initiatives, such as Help Me Grow, aim to provide a way for anyone, such as caregivers or daycare providers, to refer a child for an assessment, increasing the likelihood of accessing needed services early (Bogin, 2006).

7.3. Educational program quality standards

Apart from experiences with caregivers in the home, 33% of children under age five also have early educational experiences with caregivers outside of the home in settings such as daycare or preschool (Laughlin, 2013). The quality of these out-of-home experiences can contribute to early language development, as interactions between staff and children are, ideally, contributing to language learning. In determining early childhood programs that provide beneficial learning opportunities for children, Quality Rating and Improvement Systems (QRIS) and organization-based quality standards and provide helpful guidelines. Standards and criteria for QRIS include quality-markers in multiple areas of child development, licensing requirements, and guidelines for children with special needs (National Center on Early Childhood Quality Assurance, 2015). Although specifics vary by state, some requirements related to funding include using appropriate early childhood curricula and conducting assessments with approved tools (Mitchell, 2005).

Organization-based quality standards include the National Association for the Education of Young Children (NAEYC) and National Institute for Early Education Research (NIEER). NAEYC promotes high-quality learning for children birth to eight years and aims to implement best practices and high-quality programs. Accreditation from NAEYC can assist families in understanding programs that the association views as high-quality. NIEER focuses on promoting early learning and evidence-based policy by collecting information on early education access and quality (NICHD NIEER,

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2017). In 2016, NIEER released 10 quality standards benchmarks aligned with early childhood research including a low staff-child ratio (1:10), screenings and referrals, continuous quality improvement system, and comprehensive Early Learning and Development Standards. In turn, each of these standards may increase the quality of caregiver–child interactions by providing more opportunities for direct attention, identifying children's needs, committing to high-quality early childhood environments, and prioritizing comprehensive standards. NIEER tracks the progress of programs and states annually and has noticed remarkable progress in states' commitments to offering the best-quality early childhood education.

In summary, many policies are so distal to caregiver–child interaction that many caregivers may not be able to articulate their presence or importance for improving language outcomes. However, policies increase the time young children spend with caregivers well-equipped to sensitively and frequently interact, as well assuring each child's development is monitored, and supplemental intervention services are provided. In these ways, policies (and the regulations and funding programs that follow from them) set into motion various processes that, in turn, may provide for more developmentally supportive interactions for young children.

8. Discussion

We began this paper with a description of the need to better understand and organize the myriad of variables affecting outcomes in children's language development. Toward that end, we have argued an ecobehavioral model coherently captures influential factors of language development in ways that explicitly describe how a variety of more distal factors may affect development through their effect on core learning opportunities. We argue language learning occurs within the context of caregiver–child interactions, wherein the child is an active participant as the caregiver provides the essential opportunities to interact and functional consequences for the child's communicative acts. We attend to three additional levels that may exert influence on magnitude of language learning by, in turn, affecting these interactions in an increasingly distal manner. These levels include: (a) the caregiver knowledge, beliefs, and behavior; (b) environmental components and resource availability; and (c) policies and practices. Underlying the description of these levels of influence, however, there is a clear need to understand the benefits and implications the proposed model has for research, practice, and child outcomes.

A clear benefit of the model is its organized framework for considering the multiple, functional avenues of action and intervention when researchers and practitioners are aiming to increase the probability of quality interactions that promote language development (e.g., Biglan & Hayes, 1996; Rogers-Warren, 1977). That is, depending on what features are already in place and what resources are available to caregivers and children outside of the interaction itself, researchers, practitioners, and caregivers can leverage existing variables to promote children's language development. For example, a family may not have the economic resources to visit community settings, such as restaurants, zoos, or museums, regularly. They can, however, set out cooking utensils to use and talk about in pretend play with their young child to facilitate sustained interactions that introduce new vocabulary. Thus, a lack of resources does not inhibit language development, as the interaction itself can still occur, but influences the types of occasions for those interactions. Similarly, improvements in interactions in this scenario may be accomplished by intervening with caregivers to show them how to use resources they already have to vary and/or expand the language and actions in the experience, which is not dependent on their SES status.

Given these benefits, our proposed model suggests several implications for research and practice. First, a complete analysis of language learning and the features that affect it will require attention across different levels of influence; it is crucial for researchers and community partners to create protocols and practices that encompass these multiple levels. Relations within and across levels of the model proposed here suggest targets for intervention can vary in proximity to language-learning opportunities and that analysis of effects across levels (and, thus, on opportunities for caregiver–child interactions) is essential. Table 1 presents potential action items by level of influence and the intended outcomes, which may support future programing efforts in thinking through and encompassing as many features across levels as possible. Some of this work is already underway within current public health research and prevention models aimed at addressing the word gap. For example, Greenwood et al. (2017) conceptualized a comprehensive prevention intervention approach that involves the use of targeted, effective interventions at the population, community, adult (i.e., caregiver), and child levels simultaneously. This work can be further grounded and guided by an ecobehavioral model, such that the multi-component, concerted efforts align with the levels of influence proposed here and have an aim of improving child and population outcomes.

Second, using this model to maximize language development in early childhood may contribute to improved academic performance during elementary years, as a growing body of evidence links early language development to both preschool early literacy development and later reading competence. Walker, Greenwood, Hart, and Carta (1994) demonstrated that early language development outcomes were strongly related to decoding and reading comprehension outcomes in early elementary school. This work has been replicated and extended, with implications for both development of code-referenced phonological awareness skills (Cassano & Schickedanz, 2015; McDowell, Lonigan, & Goldstein, 2007) and more competence in general knowledge, comprehension, and approaches to learning (Fernald & Weisleder, 2011; Kendeou, van den Broek et al., 2009; Scarborough, 2001; Van Den Broek, Kendeou, Lousberg, & Visser, 2011).

Given the unique and important contributions of literacy to lifelong success, this feature of developmental continuity is especially important. One can argue that, to date, research on early language development and early literacy development has proceeded in parallel, loosely-connected ways. At a minimum, research has identified temporal developmental relations that may, in fact, be functional developmental relations between child behaviors typically associated with "language development" and those more topographically associated with "early literacy development" (e.g., Kendeou, Savage, & Broek, 2009; Walker et al., 1994).

We also suggest this model extends to children whose communicative development is non-normative, including children with disabilities and/or those who rely on augmentative and alternative communication (e.g., AAC; sign language, text-to-speech device). While our analysis here has focused primarily on children who are typically-developing and/or at-risk for delays, we assume many issues identified here describe similarly optimal developmental outcomes for children with identified disabilities, including those who use alternative language systems. The function of each of the levels of the model remain the same – all children need quality interactions to develop language, regardless of disability status – but forms of child and caregiver behavior as well as many of the more distal factors may vary based on specific characteristics of the child. This, in turn, means some children may require more intentional, adapted, and/or individualized instruction and experiences to develop language than their typically-developing peers, but many children with disabilities, even very young children, can

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Table 1
Potential action items and intended outcomes from implementation of an ecobehavioral model of language development.

Action items	Intended outcomes of action item
Increase caregiver–child interactions by:	
Promoting caregiver initiation of interactions	Caregiver begins to use prompts within the environment that initiate interactions and provide the child with an opportunity to respond
Promoting caregiver maintenance of interactions	Caregiver provides functional consequences and responses to child initiations and communicative bids that maintain interactions
Supporting active participation of the child	Child learns his/her role and begins initiating interactions, as well as responding to caregiver communicative bids
Increasing the frequency and quality of interactions	Caregiver and child engage in frequent and high-quality interactions that contain diverse vocabulary, expansions, recasts, and iterative turns
Increase caregiver knowledge, beliefs, and behaviors by:	
Expanding access to child development information	Caregiver gains knowledge of child language development and strategies that increase probability of interactions
Expanding access to parent education programs	Caregiver's capacity for initiating and maintaining frequent, high-quality interactions increases through exposure to information, experiences, and activities
Address environmental components and resource availability by:	
Increasing access to and diversity of materials and resources	Materials and resources (e.g., books, toys, household items) serve as prompts to increase probability of diverse language rich interactions
Supporting caregiver–child participation in variety of experiences	Diversity of environmental prompts (e.g., zoo, museum, parks) serve to increase probability of interactions
Encourage policies and practices that:	
Address parental leave	Increase amount of time caregivers have to spend with children in the early years
Lower adult–child ratios in early childhood programming	Increase probability for 1:1 caregiver–child interactions
Support staff training	Increase knowledge of child development and importance of interactions for language learning
Promote educational program quality standards	Adopt guidelines and standards that increase quality of childcare environments
Identify and address developmental concerns in a timely manner	Detect concerns early and provide early intervention to maximize interaction learning opportunities
Address the influence of time on the overall model by:	
Promoting continual access to interactions, with attention to key developmental periods	All variables within the ecobehavioral model (i.e., caregiver–child interactions; caregiver knowledge, beliefs, and behaviors; environmental components and resource availability; and policies and practices) are attended to and strategized with respect to key developmental periods and differences across the lifespan

successfully develop communication and language in some form (e.g., Romski, Sevcik, Barton-Hulsey, & Whitmore, 2015).

We know exposure to interactions is crucial for individuals with disabilities (Spiker, Boyce, & Boyce, 2002), and factors such as caregiver beliefs about the cause of their disabilities (e.g., Danseco, 1997; Harry, 2002), SES (e.g. Sontag & Schacht, 1994), and policies such as a right to early intervention, all influence language development (e.g. American Speech-Language-Hearing Association, 2008; Moeller, 2000). Future research and community efforts should investigate how this model extends to these instances to determine if this model is appropriate and produces optimal language and, potentially, later literacy outcomes. If it is appropriate, this model may set a framework for an early intervention language program.

While this model proposes a way of conceptualizing the current literature related to language development, there are several limitations. First, the model as a whole has not been empirically tested. This model is falsifiable and it may be shown that one or more of the variables or levels described here do not, in fact, affect the magnitude of language development; it may also be that relations within and between levels of the model are different than we have proposed. In addition, consistent with the emphasis on intervening variables, ecobehavioral models are inherently inductive. As a result, explanatory models may grow in detail or complexity over time as new contributors and relations are identified. Second and closely related, this emphasis on demonstrable and manipulable relations may produce results some find too simplistic particularly due to the exclusion of contemporary descriptive methods (e.g., Binder et al., 1997). We therefore acknowledge the analysis here is incomplete, both with respect to important variables within each of the levels of the model proposed here and perhaps even in number and/or definition of these "levels." Future research and scholarship are needed to both more fully explicate factors within the levels proposed here and to critically evaluate and perhaps revise the number, definition, or distal/proximal position of categories of these factors. Likewise, it is crucial to fully define and measure each variable of interest. For example, simply measuring how many words are spoken to a child does not account for how many prompts there were for the child to respond, the quality of the caregiver prompts, and the length of the interaction was between the caregiver and child. More nuanced variables or an increase in features that make up language may yield more insight into the nature of language and interactions. Finally, the purpose of this paper was to develop an ecobehavioral model specific to language development. The extent to which this model is applicable to other developmental skills remains to be seen, but similar approaches may be useful given current thinking and investigations related to skill development in mathematics (e.g., Blevins-Knabe & Berghoust Austin, 2016) and literacy (e.g., Aram & Korat, 2010). Future exploration is recommended.

9. Conclusion

We argue here for the basic idea that interactions between child and caregiver(s) is of central, causal importance, and that other factors are distal and necessary, but not sufficient, to affect language outcomes by influencing the amount and type of these interac-

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tions. How these more distal factors are grouped and described may be informed by both further conceptual and theoretical analysis, and eventually by empirical analysis that identifies both distinct and unified variables and the mediating or moderating relations among these variables and caregiver–child interactions. Future work should aim to empirically test the bidirectional, multilevel nature of language development presented here. A cohesive ecobehavioral model of language development can inform future interventions and community action plans to best support young children's development and later life outcomes. To close, in the words of Hart and Risley (1995), "Experience is cumulative; new experiences are recognized, added, and assimilated to past experiences or let go unnoticed or unnamed because there are no words and no past experiences with which to link them" (p. 188).

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Declarations of interest

None.

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