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Developmental Science and Preventive Interventions for Children at Environmental Risk

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Abstract

The current status of preventive intervention programs for young children at environmental risk designed to reduce the school readiness gap is examined in the context of developmental science. A review of program effectiveness suggests that future progress may depend upon committing to a specific developmental approach consistent with the knowledge base of developmental science and establishing a generally agreed upon and unambiguous framework, set of goals, and associated mechanisms. The Developmental Systems Approach is suggested as one model that is consistent with developmental and existing intervention science, supporting an emphasis on program continuity, relationships, and comprehensiveness. A long-term plan for community-based systems development is presented.

Keywords

Environmental risks; Preventive interventions; Developmental systems approach

It has been well established that disproportionate numbers of young children raised in economically disadvantaged environments are not sufficiently prepared for the academic and social demands placed upon them by the time they reach school age. A school readiness gap in comparison to more advantaged peers often marks the beginning of a difficult passage throughout the school years resulting in lower scores on achievement tests, higher rates of early school drop-out, increased grade retention, and more frequent placement in special education (Evans & English, 2002; Heckman, 2006; Shonkoff & Phillips, 2000). As adults, this trajectory is often followed by lower levels of productivity as well as numerous difficulties integrating into the community.

During the early childhood period, indicators of an impending school readiness gap are evident especially for measures of cognition and language (Hoff, 2013; Noble, McCandliss, & Farah, 2007). More complex organizational processes that depend upon these more fundamental developmental resources to achieve a specific social or cognitive goal are also affected, particularly executive function and emotion regulation (Blair & Diamond, 2008; Lengua, Honorado, & Bush, 2007; Mezzacappa, 2004). Ultimately, early and later school

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failure takes a toll on motivational processes and children's self-esteem. As noted below, developmental science has been successful in identifying specific factors contributing to this trajectory as well as many of the developmental mechanisms that are operating. The expectation is that this understanding will inform preventive intervention programs designed to minimize or even eliminate the school readiness gap.

The purpose of this article is to examine the current state of preventive interventions for young children at risk for school achievement problems due to economic disadvantage and related environmental factors (environmental risk) through the lens of developmental and intervention science and to suggest a process for enhancing the effectiveness of those interventions. This will be accomplished by first discussing likely developmental mechanisms operating as well as the correspondence between these developmental pathways and the effectiveness of interventions in reducing the school readiness gap. This summary will provide the basis for a description of a long-term, community-based process designed to substantially improve the effectiveness of large-scale preventive intervention programs. It will be further suggested that success of this longer-term process will require not just refinements and enhancements of existing approaches but rather a commitment to a common framework by all involved. The final section discusses how major advances in reducing the school readiness gap, even carried out within a common framework, will require an almost case-by-case and community-by-community effort to construct a database of effective strategies. Once a critical mass of data within a common framework has been established, formal large-scale trials can be initiated.

Developmental Mechanisms

The severity of economic disadvantage correlates with the severity of risk to children's social and cognitive competence. Although limited financial resources is a defining feature of environmental risk (Yoshikawa, Aber, & Beardslee, 2012), it is the existence of the many co-occurring risk factors at the level of a family's resources that are of most concern (Ayoub, O'Connor, Rappolt-Schlictmann, Vallotton, Raikes, & Chazan-Cohen, 2009; Burchinal, Roberts, Hooper, & Zeisel, 2000). In particular, economic disadvantage is associated with limited social support as well as problems associated with parental mental and physical health, educational level and intellectual ability, attitudes and cognitive readiness to parent, coping style, and perceived confidence and competence to carry out parenting roles (e.g., Bradley & Corwyn, 2002; Evans, 2004). These diverse constraints on family resources provide a sense for how these components related to both material resources and the personal characteristics of the parents can interact with one another to produce a cumulative effect with the potential to be highly damaging to a child's development (Sameroff, Seifer, Baldwin, & Baldwin, 1993).

The likely developmental mechanisms through which these family resource risk factors operate to influence a child's development have also been identified, emphasizing specific patterns of interaction between the child and family. Three general domains have consistently been found to be disrupted or be of lower quality for children at high environmental risk as compared to families without substantial environmental risk factors: (1) parent-child transactions; (2) family orchestrated child experiences; and (3) health and

safety provided by the family. Briefly, with respect to parent-child transactions, typically indicated by measures of sensitive-responsiveness, affective warmth, and engagement, parents of children at high environmental risk compared to families with minimal risk do not develop as high a quality set of relationships (transactions) involving a discourse framework (see Cristofaro & Tamis-LeMonda, 2012; Hart & Risley, 1992, 1995; Hoff, 2013; Pungello, Iruka, Dotterer, Mills-Koonce, & Reznick, 2009), an instructional partnership (see Bradley, Corwyn, McAdoo, & Coll, 2001), and socioemotional connectedness (see Bradley et al., 2001; Fish, 2004). Similarly, family orchestrated child experiences such as providing a stimulating environment, including quality child care and exposure to community learning activities, are of concern for high environmental risk families (see Bradley & Corwyn, 2002; Leventhal & Brooks-Gunn, 2003). Finally, limited family resources also constrain parents' ability to provide healthy and safe environments for their child (Evans, 2004). Among other factors, the potential for exposure to toxic substances or to experience physiological stress reactions due to general neighborhood and family turmoil can further compromise a child's developing social and cognitive competence (Blair & Raver, 2012; Evans & Kim, 2013).

Taking this one step further, an extensive body of research has indicated that this association between environmental risk factors at the level of family resources and children's social and cognitive competence, especially as manifested by the school readiness gap, is in fact mediated to a substantial degree by the quality of the family patterns of interaction discussed above (e.g., Cristofaro & Tamis-LeMonda, 2011; Guo & Harris, 2000; Raviv, Kessenich, & Morrison, 2004; Razza, Martin, & Brooks-Gunn, 2010; Smith, Landry, & Swank, 2006). Of note, both the overall quality and variations in these components over time closely correspond to variations in children's developmental patterns (Burchinal, Vernon-Feagans, Cox, & Key Family Life Project Investigators, 2008; Hirsh-Pasek & Burchinal, 2006; Landry, Smith, Swank, Assel, & Vellet, 2001; Rodriguez & Tamis-LeMonda, 2011). Taken together, for families with limited resources, components of each of the three domains at the level of family patterns of interaction (parent-child transactions, family orchestrated child experiences, providing for child's health and safety) can be said to constitute factors that place a child's development at risk. That is, the degree of risk and the accompanying quality of the components of a family's pattern of interactions are certain to influence diverse features of a child's development (Mistry, Benner, Biesanz, Clark, & Howes, 2010). Moreover, although the range of these components that mediate child development is substantial for high risk families, they tend to remain stable or decrease in quality over the early childhood period (Rodriguez & Tamis-LeMonda, 2011).

Assuming that developmental science has accurately captured the patterns of interrelationships of experientially based influences on a child's development, preventive interventions drawing on this framework will face significant challenges in order to minimize the school readiness gap. Specifically, success may well depend upon the comprehensiveness of the programs, considering all the diverse components in the three family patterns of interaction that are relevant, and attending to specific developmental tasks associated with each developmental period. Also, given the changing nature of risk factors and the close association of family patterns of interaction with child development at any developmental period, maintaining a high level of vigilance across the early childhood period to ensure as optimal a developmental environment as possible is essential.

Preventive Interventions

The consistency of the findings with respect to likely developmental patterns of influence and the many sophisticated mediational analyses of those associations clearly suggest that the relationships identified above represent, most simply and fundamentally, a system of causal influences, i.e., family resources → family patterns of interaction → child development. Admittedly, our understanding of the developmental science of these influences especially from a systems perspective, is far from complete. For example, we have only a modest understanding of the interactions among components within each of the three levels of the system, how children moderate the influence of family patterns of interaction, and how reciprocal influences among the three levels operate, particularly the influence of children's developmental and behavioral characteristics at the level of child development on a family's resources and family patterns of interaction.

These issues have for many years and continue today to occupy the attention of developmental scientists. However, paralleling these efforts has been the translation of the developmental knowledge available at the time to design, implement, and evaluate preventive intervention programs. To be sure, translational efforts at any point in time must confront a myriad of problems inherent in the translational process and be sensitive to existing cultural and philosophical issues of relevance to neighborhood and family life (see Aber, Jones, & Raver, 2007 and Halpern, 2000, for historical perspectives). For example, developing intervention curricula or strategies in a form that can be effectively and efficiently delivered and do so in a manner that is well understood and well received by those for whom it is intended constitutes an extremely difficult task. Each intervention program is also limited by the decisions that are made with respect to selection of possible intervention dimensions. Dimensions of relevance include program intensity and duration, age range targeted and other characteristics of the children and families, mode of delivery (e.g., home based, center based, some combination), types and levels of training of professionals involved, the extent to which existing community resources are utilized, and specific child outcomes selected (e.g., language only or broad-based measures of school readiness). Intervention targets (e.g., parents, teachers, extended family, other caregivers, interventionists working directly with children, various combinations) constitute another critical set of choices. A program's theory of change, to the extent one is articulated, adds a further dimension of complexity. For example, some interventions may adopt a more didactic approach whereas others may focus on more natural, informal interactions. From another perspective, programs may rely on a particular theoretical approach related to forming an instructional partnership (Vygotsky, 1978) or emphasize the importance of addressing a parent's own close relationships as a pathway to promoting better socioemotional connectedness between parents and children (Berlin, 2005).

As might be expected, these complexities have given rise to an array of equally complex and diverse preventive interventions over the years. Of course, historically, no linear progression of intervention approaches utilizing a common framework can be found as various programs applied the developmental knowledge available at the time. Combinations of intervention dimensions noted above were selected based not only on the program's conceptual framework and clinical intuition but on practical constraints. Nevertheless, however defined

and organized, most preventive intervention programs remained well within the parameters of developmental science. For parents, especially during the first three years of the child's life, programs sought to strengthen parent-child interactions in a manner that supports their child's development by enhancing parent sensitive-responsiveness and affective warmth while encouraging high levels of parent-child engagement. Surprisingly, limited work targeted relationships as an endpoint but successful programs promoting parent-child interactions likely had this effect. Programs often involved establishing or supporting quality child care and pre-kindergarten programs. These have been central features of many interventions from the beginning. A smaller number of intervention programs have also attempted to figure out ways to encourage families to have their child participate in as many stimulating activities as possible both at home and in the community. Similarly, promoting a child's health by providing nutrition, screenings, or referral to health resources has often been included. A few programs concentrated on anti-poverty measures or directly supported parents' mental health. The expectation was that experiences involving the child at the level of family patterns of interaction (i.e., parent-child transactions, family orchestrated child experiences, health and safety provided by the family) would be enhanced by reducing the extent of family resource risk factors.

Program Effectiveness

Trying to extract meaningful patterns related to the effectiveness of numerous preventive intervention programs given their diversity at every level is extraordinarily challenging. Taking the most general approach to this problem, a series of meta-analyses and systematic program reviews attempted to identify those preventive intervention programs and specific program components that effectively reduced the school readiness gap and even produced longer-term benefits for children at environmental risk. Recent quantitative and qualitative reviews and analyses of these numerous heterogeneous programs have been less revealing than one would have hoped yet have been able to demonstrate important benefits. The most consistent findings indicate the value of center-based programs for preschool age children in the cognitive domain. Briefly, children's cognitive competence improves in response to participation in center-based programs for preschool age children in the form of both intelligence test performance and performance on various school achievement tests (Anderson, et al., 2003; Barnett, 2011; Blok, Fukkink, Gebhardt, & Leseman, 2005; Camilli, Vargas, Ryan, & Barnett, 2010; Protzko, Aronson, & Blair, 2013). However, effect sizes for these measures tend to be modest and fade over time, although positive longer-term effects assessed in terms of frequency of grade retention and similar measures do suggest that these programs may well generate more general benefits to society including economic ones (Heckman, 2006; Reynolds & Temple, 2008).

Yet it has been extremely difficult to consistently identify the dimensions of these diverse programs, such as duration of intervention, that contribute to effectiveness. Some analyses suggested that programs involving parents in a significant way add value to center-based programs (see Blok et al., 2005) but a thorough meta-analysis of home visiting programs revealed many concerns (Sweet & Appelbaum, 2004). For some programs effect sizes were found to be small for child cognitive outcomes and even smaller for parenting outcomes. Of importance, the programs selected for the home visiting meta-analysis were themselves

extremely heterogeneous, with varying degrees of program emphasis including parent education, parent social support, the provision of information on child development, and parent coaching, among others. However, no consistent patterns contributing to the benefits obtained could be identified with confidence.

It is the case that early model demonstration projects such as the Abecedarian and Perry Preschool projects (Ramey & Campbell, 1984; Weikert, 1998) provided a greater degree of optimism with respect to what could be accomplished in both the short and longer-term as well as in terms of cost effectiveness. More contemporary model interventions focusing on parents such as the PALS (Landry, Taylor, Guttentag, & Smith, 2008), the Nurse/Family Partnership (Olds, 2006), as well as very high quality pre-kindergarten programs (Gormley, Phillips, & Gayer, 2008) similarly provide an indication that much can be accomplished as a consequence of these programs. Yet when many of the principles and practices of these model demonstration programs are applied on a larger-scale, similar effects are rarely achieved. This is not always the case as found in the more focused but still larger-scale community-based program such as the Child-Parent Development Centers, but even here effect sizes for school achievement diminish substantially over time (Reynolds & Temple, 2008). Nevertheless, major, publically-funded large scale programs including the Comprehensive Child Development Program (Goodson, Layzer, St.Pierre, Bernstein, & Lopez, 2000), Head Start (Puma, Bell, Cook, Heid, & Lopez, 2005; Puma, Bell, Cook, Heid, Shapiro, Broene, & Spier, 2010), and Early Head Start (Anderson et al., 2003; Love, Chazan-Cohen, Raikes, & Brooks-Gunn, 2013), have fallen far short of expectations. Indeed, for Early Head Start in particular where the intent is to reach families at the earliest possible time, the cognitive ability of children participating still declines over time (Vogel, Brooks-Gunn, Martin, & Klute, 2013) and the learning environment provided by parents continues to be far less than optimal overall (Rodriquez & Tamis-LeMonda, 2011).

These modest effects are partly attributable to variations in the quality of implementation and the diversity of approaches taken by individual programs within the scaled-up networks. Other factors that may account for these findings relate to higher quality experiences of control group participants provided by the community and better quality of subsequent school environments. At the same time, much has been gained from analyses of these large datasets. The quality, intensity, duration, continuity over time, and comprehensiveness of interventions have emerged as dimensions to focus on that are likely to yield outcomes that can meaningfully reduce the achievement gap (Brooks-Gunn, 2011).

Refinements and Enhancements

Most recently, the development and application of new intervention strategies have sought to capitalize on the growth of larger-scale programs in communities and utilize their infrastructures to refine and enhance these programs. Such refinements and enhancements applying contemporary developmental principles and practices have indeed been the focus of numerous studies in recent years. Of special note are efforts directed at children's organizational processes, often focusing on executive function and emotion regulation (Bierman, Nix, Greenberg, Blair, & Domitrovich, 2008; Diamond, Barnett, Thomas, & Munro, 2007; Raver, Jones, Li-Grining, Zhai, Bub, & Pressler, 2011), the knowledge and

skills of professionals involved, particularly training with respect to language and literacy (Dickinson, 2011), parent training, especially to enhance their levels of sensitivity and responsiveness during parent-child interactions, also with a special emphasis on language and literacy (Whaley, Jiang, Gomez, & Jenks, 2011), and efforts to address the level of family resources, primarily anti-poverty programs and those designed to reduce maternal depressive symptoms (Aber, Morris, & Raver, 2012; Beeber, Holditch-Davis, Belyea, Funk, & Canuso, 2004). Many of the benefits from these refinements and enhancements have been small, especially when carried out as additions to existing programs. Yet each increment can, like risk factors, substantially contribute to producing a meaningful cumulative effect.

Next Steps and the Developmental Systems Approach

Clearly, significant progress has been achieved but, as we have seen, the gap is far from being closed for a substantial proportion of children at environmental risk. Combining our now more extensive knowledge base and applying it to design a fully comprehensive preventive intervention program would seem to be a logical next step to address this problem. Yet, especially for the more recent refinements and enhancements, intervention approaches have been highly diverse despite a general reliance on findings from developmental science. Differences were common with respect to conceptual frameworks, curricula, the number and type of program components, age ranges of the children, involvement of existing community resources, relative emphasis on parent and child-focused services, intensity and duration of the intervention, and professionals included, among many other dimensions. As a consequence, integrating and organizing this information in a coherent manner that lends itself to systematic programmatic change at the community level is extremely difficult to accomplish. In view of this complexity, next steps to creating a truly comprehensive program may well require making a commitment, perhaps involving some level of arbitrariness, to a specific framework and then initiating a long-term process of program development and evaluation within that framework. The ultimate goal is to construct programs that can be applied at an increasingly larger scale.

One framework capable of unifying and integrating these diverse intervention efforts is the Developmental Systems Approach (DSA) (Guralnick, 2011, 2012). Although the structure and function of the DSA is similar to many other models in developmental science, it may offer a number of advantages when considering the future design of larger-scale comprehensive preventive intervention programs for children at risk due to environmental factors. Of considerable significance, the DSA explicitly identifies components, particularly those comprising family patterns of interaction, that would be the focus of preventive interventions. More generally, it specifies a framework, set of goals, and mechanisms that would drive assessment, intervention, and evaluation. The framework, goals, and mechanisms would need to be well understood and agreed upon by all involved including immediate and extended family, others constituting the family's social support network, child and teacher/care staff, health professionals, community leaders and, of course those organizing and guiding the comprehensive intervention itself. Of importance, the DSA does not seek to constrain but rather encourages diverse and creative intervention approaches. However, it focuses these efforts on ways to enhance components of family patterns of interaction. Compatible interventions have been identified and the DSA is being applied in

numerous countries throughout the world (Bruder & Guralnick, 2012; Guralnick, 2005). Moreover, the DSA emphasizes relationships as perhaps the most critical component of any effort to support a child's development during early childhood and as essential to achieving longer-term benefits. As noted, attachment research notwithstanding, fostering relationships as a true endpoint of preventive interventions has been a neglected area. Contemporary developmental science as expressed in the DSA may well be able to provide needed guidance for longer-term preventive intervention program development.

Developmental Systems Approach

Figure 1 illustrates the three levels of the DSA (child social and cognitive competence, family patterns of interaction, and family resources) along with the components that constitute each level. The interrelationships among the levels of the DSA are also reflected in the figure. As discussed earlier, for children at environmental risk, limited family resources (risk factors) can adversely influence the quality of the components of family patterns of interaction. In turn, the lower quality of components of a family's pattern of interactions affect and contribute to children's non-optimal development of their social and cognitive competence throughout the early childhood period. The dotted line arrow represents the fact that children's characteristics can moderate the influence of a family's pattern of interactions. This is exemplified by recent work on children's susceptibility to environmental influences (e.g., Conradt, Measelle, & Ablow, 2013; Raver, Blair, & Willoughby, 2013), and many of these child characteristics can minimize adverse effects of even lower quality parent-child transactions. Moreover, the dashed line arrow between the level of the child and the level of family patterns of interaction represents the many successful adjustments in family patterns of interaction parents make to children as they develop, including those at high environmental risk. However, as reviewed, these adjustments do not occur adequately for many families at environmental risk, and non-optimal family patterns of interaction exert their influence on a child's development over time. As a result of increasing child developmental difficulties, family patterns of interaction and perhaps even components of a family's resources can be disrupted even further. These added child-specific challenges to the other two levels are reflected in the solid arrows labeled stressors. As noted earlier, important aspects of the quality of a family's pattern of interactions often decline across the early childhood period (Rodriguez & Tamis-LeMonda, 2011). Taken together, the DSA attempts to capture the complex interrelationships and reciprocal influences among levels and within components at each level that contribute to young children's developing social and cognitive competence.

The developmental science literature reviewed earlier appears entirely consistent with the DSA components and the pathways of reciprocal influences described. The research findings for preventive interventions for model demonstration as well as scaled-up programs, including studies focusing on refinements and enhancements noted earlier, have also found effects compatible with many of the DSA components but at times have been inconsistent and relatively weak. It is possible that the DSA framework itself is flawed, perhaps missing components or not fully understanding how patterns of influence operate in order to enhance children's social and cognitive competence. Alternatively, inconsistent and weaker findings may well reflect implementation issues related to variations in intervention

intensity and program quality, among others. Despite these problems, the long-term goal of developing highly effective scaled-up preventive intervention programs may well require a commitment to and adoption of a specific framework such as that provided by the DSA, following its principles and practices to the fullest extent possible. Perhaps in doing so, more substantial effects with respect to reducing the achievement gap will be achieved. In the following sections a plan is outlined using the DSA as this framework for the future design of a comprehensive preventive intervention system for children at risk due to environmental factors.

The Assessment Framework

Although information at the levels of family resources and child development must certainly be factored into a child's intervention program, the primary goal within the DSA is to maximize family patterns of interaction. Consequently, screening and any subsequent assessments must include all the components of family patterns of interaction indicated in Figure 1. Critical here, especially during the first years of a child's life, is establishing relationships in the form of the three types of parent-child transactions noted earlier. A number of useful measures that index these relationship processes consisting of a discourse framework, instructional partnership, and socioemotional connectedness are available and can serve as screening instruments. In particular, diverse but well established measures related to sensitive-responsiveness, affective warmth, and engagement have been developed and are available for different developmental periods (e.g., Bradley, 2012; Landry, Smith, & Swank, 2006; Tamis-LeMonda, Bornstein, Baumwell, & Damast, 1996; Tamis-LeMonda, Uzgiris, & Bornstein, 2002). Concerns with respect to any of these measures would precipitate a more extensive assessment focusing on each of the three relationship processes. It is not only relationship processes related to parent-child transactions that are critical but evidence indicates that to effectively promote children's social and cognitive competence, the same form of other caregiver or teacher-child relationships must be formed (Dickinson & Porche, 2011; Howes, Fuligni, Hong, Huang, & Lara-Cinisomo, 2013).

To be sure, much work is needed to develop tools to assess relationship processes themselves, but guidance is available. Specifically, relationships can be characterized at minimum by evidence of cooperation, synchrony, positive ambience, a shared set of explicit expectations about participants' roles as well as a clear recognition that all participants recognize that their relationships are indeed part of a collaborative enterprise (Aksan, Kochanska, & Ortmann, 2006; Feldman, 2007; Reis, Collins, & Berscheid, 2000; Tomasello & Carpenter, 2007). Of importance, this emphasis in the DSA on parent-child and other adult-child relationships will require far more intervention resources than have been typical of preventive interventions to date.

Although many of the preventive interventions reviewed earlier have emphasized one or a cluster of components at the level of family patterns of interaction, a maximum cumulative effect can only result from comprehensive interventions. Periodic screenings and needed assessments at this level in particular are essential. The DSA helps identify precisely what is meant by comprehensiveness, and all the components including relationships that constitute parent-child transactions that have received sufficient empirical support have been listed in

Figure 1. We also now have a reasonably good understanding of what constitutes high quality for all the components of family orchestrated child experiences at different time periods, including center-based programs. Moreover, parental reports, gathering existing demographic information, or involvement of health professionals can provide useful information with respect to components related to a child's health and safety. Information from local community action groups can similarly contribute to a broader understanding of neighborhood issues affecting children's health and safety.

Components at the level of family resources are clearly capable of exerting an influence on a family's pattern of interactions throughout the early childhood period and, as discussed, the effects on children's development vary with changing levels of family risk. Accordingly, although prenatal preventive interventions are important, the DSA's focus on postnatal involvement will also require periodic screenings at the level of family resources and any needed follow-up assessments throughout the entire early childhood period. Information with respect to many components of the personal characteristics of the families and material resources can be obtained from many sources. One option that has recently been developed is to involve health providers to capture the information at this level as part of a medical home protocol (Garg & Dworkin, 2011).

Focusing on the level of child development, information from routine screenings and even some in-depth assessments of children's overall developmental status is often available. Difficulties establishing high quality parent-child transactions in particular, despite our best efforts, may require more in-depth assessments to generate information with respect to children's developmental resources and organizational processes (see Figure 1). This information would be incorporated into a problem-solving process which may point toward the need for specific adaptations to children's characteristics in order to further high quality parent-child transactions or other components of family patterns of interaction.

A similar problem-solving process may be needed that incorporates information at the family resource level. Especially for circumstances of extremely high environmental risk, unusually creative approaches may be required to establish higher quality family patterns of interaction. As discussed below, a database can be established demonstrating how this process operates and the extent to which solutions arrived at were effective. Again, an agreed upon framework, goals, and mechanisms provides the overarching guidance for developing the database and facilitates communication among all those involved in the preventive intervention system.

The Intervention Framework

By committing to an approach that has sufficient conceptual and empirical support and from which corresponding practices can be derived, a long-term implementation process can be put into place. Such a process would incorporate curricula and strategies compatible with the overall DSA framework and have received sufficient evidence of effectiveness. In this way, findings from studies to further refine and enhance existing interventions, especially in connection with currently available larger-scale programs, can be utilized and then build upon the set of unambiguous goals defined by the DSA. Clearly, diversity, flexibility, and

experimentation should be encouraged but the selection of intervention strategies should not diverge from a commonly agreed upon conceptual and practice framework.

What is required is a system that focuses specifically on the components of a family's pattern of interactions, assessing the quality of each component with respect to maximizing a child's development, and then developing a set of intervention-compatible goals and strategies. This would be accomplished utilizing intervention resources that are well established or show promise based on existing empirical work, modifying those strategies based on information obtained at the level of child development and the level of family resources as needed, and establishing a process for ongoing evaluations of progress. By its very nature, this framework is firmly grounded in a problem-solving process guided by a systems perspective. As such it must encourage a creative and adaptive approach, allowing for changing priorities and incorporating into the problem-solving process not only information from developmental and intervention science but from clinical experience as well.

Systems Implementation Design

How then could we begin to design, implement, and evaluate such an all-encompassing preventive intervention program based on the DSA that will create an effective system in a defined community? First, existing efforts to establish an overarching administrative structure at local or state levels to integrate and coordinate existing subsystems relevant to preventive interventions for children at environmental risk must be accelerated. Child care, birth-to three, pre-kindergarten, Head Start, mental health, and pediatric health care are among those subsystems that are clearly relevant. Coordination and integration efforts have been pursued for many years, with success due to the extraordinary creativity and systems-level knowledge of the pioneers (see following edited volumes Perry, Kaufman, & Knitzer, 2007; Watt, Ayoub, Bradley, Puma, & Le Boeuf, 2006; Zigler, Gilliam, & Jones, 2006), but the task is far from complete. To augment these efforts, the DSA would provide a common conceptual framework and an explicit set of goals to guide future community-based systems integration activities. Even for a relatively small community effort, the task of engaging representatives of subsystems in a common effort relevant to preventive interventions is an extraordinarily complex one. Among many factors, this would involve addressing philosophical issues, identifying current and needed resources, taking into consideration community goals and parent group perspectives, acquiring appropriate staff, and agreeing on common assessments, intervention approaches, and evaluation strategies. As noted, the DSA not only provides a framework grounded in developmental science but both allows and encourages diverse approaches recognizing that many pathways exist to achieve goals associated with the components of family patterns of interaction. Sophisticated levels of leadership will be needed to build community-capacity. Excellent examples of communities moving in this direction can be found in Zigler's School of the 21st Century (Zigler & Finn-Stevenson, 2007), the Canadian effort, the Better Beginnings, Better Futures program (Peters, Bradshaw et al., 2010), and the recently developed Educare model (Yazejian & Bryant, 2012). In this context, communities mobilizing to enhance children's development throughout the early childhood period would do so guided by the framework provided by the DSA.

Complementary to and paralleling this more “top-down” process would be the initiation of a set of small scale projects, conceptualized as being long-term in nature, situated directly in a community which had committed to devising ways to better coordinate and integrate subsystems to promote the development of young children at environmental risk. Drawing upon a team of early intervention experts convened by the community group, and committed to the primary goal of maximizing family patterns of interaction, interventions would be organized on a family–by–family basis. Utilizing and pulling together existing assessments, curricular and related intervention materials, and outcome measures, this team would begin the process of implementing all aspects of the DSA. This clearly “bottom–up” approach linked to each component of a family's pattern of interaction, would generate a series of ever increasing numbers of case studies. The context, based on information at the level of family resources and the level of child development, along with the problem-solving approach to intervention taken in each instance would be entered into a database. The structure of the database would include fields designed to capture information critical to the DSA components and to the sequence of strategies generated to address problems that arose. This would provide information as to which strategies designed to influence components of a family's pattern of interactions appeared to have positive effects based on evaluation criteria and which did not given specific conditions (child characteristics and family resources). In that way, although focusing on the level of family patterns of interaction, the database would reflect those circumstances that did require more extensive assessments and the corresponding intervention approaches that were taken associated with the level of children's social and cognitive competence as well as a more direct focus at the level of family resources. Therefore, all levels of the DSA would be considered but the central goal of maximizing family patterns of interaction remains.

Developing such a database would require oversight from the larger coordination and integration efforts carried out by community members. Accomplishments by this group at this “top-down” level would benefit many components of a family's pattern of interactions as well, especially if progress was made with respect to improving a community's quality of health and safety, expanding access to stimulating community activities, and finding resources to enhance the quality of child care or preschool programs. The early intervention team however, would be responsible for addressing the various components noted in Figure 1 (“bottom-up”) for children and families participating in the smaller-scale efforts, working with child care staff or teachers for example to foster high quality caregiver/teacher-child relationships, as well as pursuing other strategies consistent with the DSA. Both types of approaches converge to strengthen a community's commitment and ability to support the development of children at environmental risk.

In many respects, what is proposed here is a combination of a model demonstration and a larger-scale community-based project; essentially a laboratory embedded in a community. It does so, however, with an explicit commitment to a model containing a strong program development component designed to be carried out over a long period of time and captured by a database comprised of multiple case studies. As evidence of significant progress emerges in establishing the system, particularly the programs' ability to substantially influence the quality of family patterns of interaction for a diverse group of families, more formal outcome evaluations, initially small scale, of effectiveness can begin. Before doing

so, a description of the model, along with instructions as to how to access the problem-solving approaches based on information contained in the database, is required. The compilation of strategies and resources already available that have been linked to changes in components in family patterns of interaction in these studies must be easily available. Of course, the search strategy would be primarily organized around the DSA components emphasizing goals associated with family patterns of interaction. When a critical mass of data containing an array of successful and well-organized strategies that have enhanced components of a family's pattern of interaction has been established, formal evaluations can begin.

Ideally, for each DSA component, a series of evidence-based curricula or strategies would be identified organized around various developmental periods. Many options for each DSA component would be available along with opportunities to modify the search depending upon specific child characteristics or family resources if needed. The program's database would essentially be a guide to problem-solving but contain or direct users to needed resources for easy and immediate access. The process would be such that users would be consistently reminded of the common framework, goals, and mechanisms. Both components, progress of the community team and family-by-family information, would be included in the database. Ultimately, as the database and organization of information become more extensive and sophisticated, small scale evaluations would give way to large scale randomized clinical trials of effectiveness in improving children's school readiness and longer-term achievement. Assessments of mediators conceptualized in the form of the DSA components as well as cost-effectiveness would be part of this process. This approach to intervention science would also likely prompt possible modifications or clarifications of our developmental science.

Summary and Conclusions

Developmental science has contributed to our understanding of the major components of and influences on a family's pattern of interactions and their likelihood of having a substantial impact on the young child's social and cognitive competence. Translating developmental science into intervention science to promote the development of children at environmental risk has been an ongoing process for decades. Important achievements from this body of work are clearly evident but, as we have seen, much more needs to be accomplished to reduce the achievement gap for children at risk due to environmental factors. As argued here, to do so may well require a commitment to a particular approach consistent with the knowledge base of developmental science and by establishing a clear framework, goals, and mechanisms associated with that approach. From that point it will be possible to gradually select and devise a coherent set of interventions for community-wide implementation.

The Developmental Systems Approach outlined in this article appears compatible with existing intervention science. It also provides a structure and filter for examining the results of difficult-to-organize refinements and enhancements of existing intervention approaches. As described, the DSA provides a framework for preventive interventions over the entire early childhood period, focuses on relationships, and emphasizes the comprehensiveness of

interventions. With complementary community level and family level participation, a database can be generated that will ultimately be transformed into and constitute the details of a preventive intervention system. Such an approach is indeed challenging as it brings into focus in a systematic way all of the complex issues that must be addressed. The long-term nature of this effort appears daunting at first consideration, but some unifying structure guiding preventive interventions for children at risk due to environmental factors appears needed for major advances to occur.

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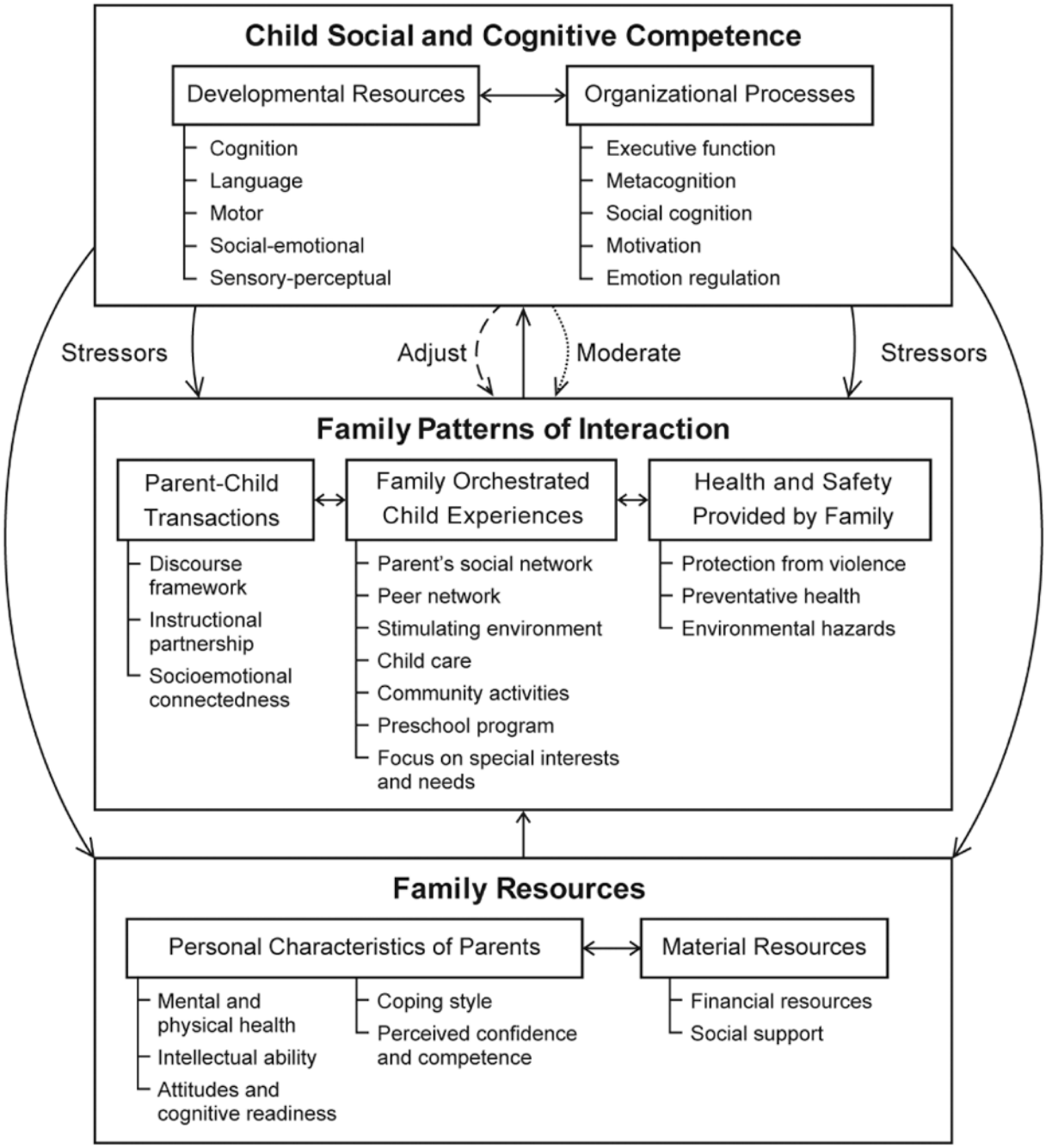

Figure 1.
The Developmental Systems Approach illustrating levels, components, and interrelationships. (adapted from Guralnick, 2011).