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Poverty's Impact on Children's Executive Functions: Global Considerations

Stephanie L. Haft, Fumiko Hoeft

Abstract

Poverty detrimentally affects child executive function (EF), a subset of cognitive abilities implicated in reading and other achievement outcomes. Consequently, research has focused on understanding explanatory and mediating mechanisms in this association. This research, however, has mainly involved populations from Western, high-income countries. Children from low- and middle-income countries comprise a significant proportion of the world's population and are at additional risk for poor EF as a result of a more disadvantaged context. The present review examines global work on poverty and EF to highlight important cross-national similarities and differences. Findings suggest a global association between poverty and EF and point to cognitive stimulation and environmental enrichment as common mediating variables that may also be moderators and targets for intervention. However, findings also underscore the need to consider the sociocultural context of countries when examining impacts of parenting, schooling, and other metrics. Research and intervention implications are discussed. © 2017 Wiley Periodicals, Inc.

Background

Childhood poverty is associated with a range of negative developmental, behavioral, and emotional sequelae that can further perpetuate inequalities in income, achievement, and health. One such outcome is impaired development of executive function (EF), a collection of goal-oriented cognitive abilities including domains of working memory, cognitive flexibility, inhibitory control, and planning. Research from developed and developing countries, including Western and non-Western societies, shows a strong relationship between socioeconomic status (SES), a metric of poverty, and childhood EF (e.g., Fernald, Weber, Galasso, & Ratsifandrihamanana, 2011; Hackman, Gallop, Evans, & Farah, 2015). Considering that poor EF can lead to impairments in academic achievement, emotional functioning, and occupational outcome (Alloway & Alloway, 2010; Miller, Nevado-Montenegro, & Hinshaw, 2012; Snyder, 2013), this relationship means that children in poverty worldwide are at risk for further negative life outcomes by virtue of EF disparities.

Despite the strong links between poverty and EF, children living in poverty exhibit individual variability in EF. Accordingly, efforts have increased to investigate potential mediators and moderators of the SES–EF association and identify targets for interventions and programs. However, this literature has focused disproportionately on children from high-income countries (HICs) in Western societies, largely neglecting children living in low- and middle-income countries (LMICs). The effects of poverty on EF are likely to be influenced by cultural practices and environments that vary across countries, suggesting mediation analyses conducted in HICs may not be applicable in LMICs. Additionally, gradients and severity of poverty may be more extreme in LMICs in the context of fewer governmental resources—over 200 million young children in LMICs do not reach the full cognitive potential they would attain in a more nurturing environment (Grantham-McGregor et al., 2007). Thus, EF research that informs interventions to be implemented in LMICs is crucial (World Bank, 2015), especially for those children who reside in more disadvantaged contexts.

Accordingly, we review research on poverty and EF in a global context, focused primarily on research from HICs on why poverty is linked to poorer EF, potential global influences on these pathways, cross-national variability in mediators, confounding factors and challenges involved in global research on EF and poverty; we suggest future research with implications for interventions seeking global impact. Given the salience of EF in a range of achievement outcomes, our goal is to contribute to knowledge aimed at lifting all children in all countries out of the vicious cycle of poverty and inequality.

Pathways Linking Poverty to Inequalities in EF Development

In the past decade, research focused on elucidating why poverty detrimentally affects EF highlights poverty's stressful impact on neuroendocrine and brain function. Children living in poverty are exposed to a range of psychological, environmental, and biological stressors that may have a direct impact on EF and/or lead to elevated levels of cortisol, a stress response hormone regulated by the hypothalamic–pituitary–adrenocortisol (HPA) axis. Stress hormones in turn regulate synaptic and neural activity particularly in the prefrontal cortex (PFC), the home of EF (see Blair & Raver, 2016; Johnson, Riis, & Noble, 2016 for reviews). As a result of neuroendocrine changes related to stress, children in poverty may experience damaging structural changes in the PFC, leading to poorer EF. Although globally the explanatory power of these stressors may vary in strength and/or with the presence of additional factors related to living in an LMIC, research confirms an association between poverty and additional stressors regardless of culture or country.

Mediators and Moderators of the Poverty–EF Link: Similarities and Differences Across Countries

Further explaining how poverty affects EF and potential ways to mitigate these effects, research from HICs has converged on candidate mediators involving parental caregiving, the provision of a cognitively enriching environment, and biological and neural differences. We examine this literature, including the limited work on this topic from LMICs, to highlight similarities and differences between contexts.

Parenting. Multiple studies within HICs have reported a positive association between aspects of parenting and child EF performance (e.g., Bernier, Carlson, & Whipple, 2010; Hammond, Müller, Carpendale, Bibok, & Liebermann-Finestone, 2012). Specific attention has been paid to scaffolding, parental autonomy support in guiding a child's goal-directed activities, and parental sensitivity in promoting EF development (Hammond et al., 2012). Concurring with this, research on mediators of the poverty–EF relationship has highlighted the role of parenting. Parental responsiveness (Sarsour et al., 2011) and maternal sensitivity in early childhood (Hackman et al., 2015) mediated the association between family SES and EF in U.S. children from diverse SES backgrounds, affecting children's cortisol levels, a proxy for stress (Blair et al., 2011). Together, these results echo work on the impact of economic stress on caregiving practices, and they also suggest parenting's role as a moderator with buffering effects. In other words, positive parenting can regulate a child's stress response in the face of poverty, thereby countering the negative impact of stress physiology on child cognition and EF.

The ability of parents in LMICs to intervene in their child's EF development may be more limited. Poverty in LMICs can be more extreme;

additional stressors (e.g., infectious diseases, environmental toxins, food scarcity) lessen capacity for parents to invest in scaffolding their children's cognition (Walker et al., 2011). Sometimes parents may not be present at all—as with street children (youth who reside or work on the streets for an extended period of time without adult supervision), who comprise a proportion of the population in many developing countries (de Benitez & Hiddleston, 2011). Two studies of street children in LMICs have confirmed the poverty–EF link found in Western literature (Dahlman, Bäckström, Bohlin, & Frans, 2013; Pluck, Banda-Cruz, Andrade-Guimaraes, & Trueba, 2017). However, researchers studying boys in Bolivia found that street children scored significantly higher on an EF flexibility and planning tasks than housed counterparts of similarly low SES (Dahlman et al., 2013). Similarly, a study of children in Ecuador found that the street children had surprisingly preserved EF (Pluck et al., 2017). Within these countries' social and cultural contexts, exercising EF in navigating street life may confer a slight advantage to some low-SES children.

Though studies of street children who lack parental supervision may seem to be at odds with parenting, poverty, and EF literature in HICs, the results actually support the role of scaffolding in EF development. The LMIC street children's EF was likely attributable to opportunities to independently exercise problem solving and executive planning rather than to lack of parenting (Dahlman et al., 2013), which agrees with the goal of parental scaffolding—to provide guidance without direction to enable children to generate solutions autonomously. Although these studies from LMICs therefore support the role of parents in mitigating effects of poverty on EF, they also suggest that the social and cultural contexts of parenting need to be considered.

Environmental Stimulation and Enrichment. Another determinant of a child's EF development is access to stimulating materials in the home environment (books, computers, etc.; Dilworth-Bart, 2012; Hughes & Ensor, 2009). Animal models have shown that cognitive stimulation promotes synaptic changes in the hippocampus and cortex that in turn lead to improved cognitive performance (Hackman, Farah, & Meaney, 2010). Research has found that an enriching home environment does indeed mediate the SES–EF association (Dilworth-Bart, Khurshid, & Vandell, 2007; Sarsour et al., 2011), even after adjusting for correlation with other candidate mediators (Hackman et al., 2015). Studies from LMICs (Zambia and Argentina) also show the mediating effect of early cognitive stimulation in the home (McCoy, Zuilkowski, & Fink, 2015), specifically literacy and computer resources. The traditional definition of cognitive stimulation, typically access to literacy resources, may need to be reexamined across cultures where caregivers may stimulate their children in other ways (McCoy et al., 2015). However, the existing results suggest that the model in which a stimulating home environment mediates between SES and EF holds true across countries.

Families in poverty have fewer financial resources to invest in enriching materials, resulting in inequalities in EF development across SES (family investment model; Conger & Donnellan, 2007); this may be exacerbated by “book deserts” observed in low-income U.S. neighborhoods (Neuman & Moland, 2016), or reduced access to print in LMICs with many remote areas (Spaul & Taylor, 2014). However, these findings suggest an EF intervention target for low-SES communities; an intervention program to offset the effects of poverty by providing cognitively stimulating environments has demonstrated positive effects on EF in children in Pakistan (Obradović, Yousafzai, Finch, & Rasheed, 2016). Such interventions can be applicable worldwide.

Biological Mediators. Stress physiology has received attention in poverty and EF research. It is negatively affected by poverty, ultimately having a deleterious effect on a child's EF. However, following a model of differential susceptibility (Pluess, Stevens, & Belsky, 2013), not all children exposed to the stressors of poverty will be equally reactive. Research in the United States has confirmed that biological indicators of stress such as salivary cortisol (Blair et al., 2011) and allostatic load (Evans & Schamberg, 2009) mediate between SES and EF and that, behaviorally, observed child temperament reactivity moderates the SES–EF link (Raver, Blair, & Willoughby, 2013); children more biologically reactive to adversity may be particularly at risk for low EF in the face of poverty, whereas less reactive children may be somewhat protected (Obradović, 2016).

A relationship between economic background and cortisol response has been observed in Dominica (Flinn & England, 1997), rural Mexico (Fernald & Gunnar, 2009), and Nepal (Worthman & Panter-Brick, 2008), yet these studies have not included EF outcomes or mediation analyses. Examining the relationship between stress physiology and EF outcome in LMICs is a future research direction but may be confounded by nutrition: child stress physiology varies as a result of stunting in low-SES samples (Dobrova-Krol, van Ijzendoorn, Bakermans-Kranenburg, Cyr, & Juffer, 2008; Fernald, Grantham-McGregor, Manandhar, & Costello, 2003; Nyberg et al., 2012). Stunting (delayed height-for-age), resulting from chronic malnutrition and affecting ~165 million children in developing countries (De Onis, Blössner, & Borghi, 2012), negatively affects general cognitive development (Ajayi et al., 2017). These, together with nutrition's impact on stress physiology, should be considered an important player in EF outcome in LMICs.

In a study of EF in low-income Zambian children (McCoy et al., 2015), stunting explained the SES–EF relationship and predicted EF above and beyond early learning experiences. Although height-for-age may not be an appropriate research variable in HICs where severe malnutrition is rare, these findings underscore the importance of including anthropometric data in EF mediation research in LMICs. This research is an indirect but promising way of supporting child EF in LMICs, as targeted interventions can reduce

stunting (Rockers et al., 2016). Work on biological stress reactivity and EF in LMICs, therefore, should include the impact of stunting both on stress and on EF.

Neural Mediators. Many studies link SES to individual brain differences, underscoring the role of brain development in the poverty-to-EF pathway (see review by Blair & Raver, 2016). These studies demonstrate that poverty affects neuroanatomy and neurophysiology through biologic and epigenetic mechanisms and thus has a detrimental effect on EF development (Johnson et al., 2016). Only one study has replicated work on neural correlates of EF in an LMIC population. Tarullo et al. (2017) examined the relation of EF to gamma activity in a disadvantaged population of rural Pakistan, showing that gamma power was indeed a “neural marker” for EF performance in LMICs as is the case in HICs (Benasich, Gou, Choudhury, & Harris, 2008; Brito, Fifer, Myers, Elliott, & Noble, 2016), suggesting cross-national relevance of the metric (Tarullo et al., 2017). Despite the lack of mediation analyses, this result supports HIC findings pointing to brain development as an SES–EF mediator and suggests that neural measures may be an important, unbiased indicator of EF that is valid across countries and contexts, in contrast to many existing behavioral measures. Although the limited portability and affordability of neuroimaging tools makes implementing research on brain correlates of EF in LMICs challenging, identifying neural correlates and mediators can be valuable in understanding the pathways from poverty to outcome for at-risk children. Future work might also investigate the impact of other neural patterns affecting the SES–EF link as moderators or confounders, for example, developmental differences in temporal or hippocampal regions (Hair, Hanson, Wolfe, & Pollak, 2015).

Additional Considerations in Scaling Poverty–EF Work Globally

In scaling work on poverty, EF, and their mediators to LMIC countries, several confounding variables that affect child development need to be considered—nutrition, infections, toxins, learning opportunities, exposure to violence, and general cultural and geographic considerations, vary widely (for review, see Walker et al., 2011). In general, the poverty cofactors and associated stressors that explain inequalities in EF development in HICs are the same but exacerbated in LMICs. A lack of learning materials, poor housing quality, prevalence of maternal depression, and childhood trauma exposure are all negatively associated with a country’s gross domestic product (Bradley & Putnick, 2012), and all of these risks affect child EF directly or through their detrimental impact on epigenetic or neuroanatomical systems (DePrince, Weinzierl, & Combs, 2009; Hackman et al., 2010; Schapkin, Falkenstein, Marks, & Griefahn, 2006). Therefore, research on EF in LMICs may need to place an emphasis on controlling for the many impactful cofactors of poverty.

Metrics involved in this area of research also need to be carefully chosen and operationalized; for example, despite recent work on developing culturally sensitive assessments, EF tasks may still be affected by cultural norms, e.g., the importance of speed in certain cultures (Armengol, 2000). Additionally, the income- and needs-based frameworks that define SES in HICs may not be applicable to LMICs; recommendations for improving the measurement of poverty in child development and EF research thus include incorporating cultural contexts as well as cognitive and neural indicators or outcomes of poverty (Duncan & Magnuson, 2012; Lipina, Simonds, & Segretin, 2011). Cultural tendencies may also have an impact on cognitive processes; for example, East Asian children tend to score higher on EF tasks than their Western counterparts (Oh & Lewis, 2008), and authors suggest the disparity may be attributed to cultural differences in context sensitivity.

Conclusion and Implications

The research reviewed here highlights commonalities and key contextual differences across countries in regard to poverty and EF research. Poverty cofactors that contribute to EF discrepancies in HICs exist in LMICs but to a larger extent and alongside additional stressors. Cognitive stimulation appears to be a mediating variable globally. Parental caregiving practices play an important role in promoting EF but may vary culturally, and the relevance of intervention targets may vary by culture or country. For example, interventions for stunting, although these mediate poverty and EF outcome, are only relevant where stunting occurs, and parent-based EF or poverty programs are less impactful where parental involvement or capacity is low.

Overall, the findings highlight the need for increased mediation and moderation analyses as well as work on neural correlates in LMICs as directions of future research. In the pathway from poverty to child EF outcome, there are multiple entry points for targeted interventions, all of which may be affected by global variations. Because research on poverty cofactors and mediating variables informs such interventions, it is important that findings be applicable to all children. A large body of literature associates child EF with a range of achievement outcomes, including reading and mathematics (Cragg & Gilmore, 2014; Guajardo & Cartwright, 2016). Thus, protecting against poverty's detrimental impact on EF is important in promoting academic success in children worldwide, enabling them to break out of the vicious cycle of inequality and health disparities.

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