

Specificity of the associations between socioeconomic deprivation factors and neurocognitive development

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Executive Summary

- Studies of the associations between socioeconomic deprivation and neurocognitive development are mostly based on indicators of income, education, and parental occupation.
- The interchangeable use of these indicators does not consider the specificity that each one has in its relationships with neurocognitive development.
- The use of these indicators does not sufficiently consider the complexity of the experience of socioeconomic deprivation in children, adolescents, and youth, and its specific associations with cognitive performance.
- It is necessary to deepen the knowledge of the inter-relatedness of these associations and reconsider their use in contexts of design, implementation, and evaluation of policies on poverty and neurocognitive development.

Socioeconomic deprivation

Socioeconomic status (SES) refers to an individual's or a family's social standing or position within society based on a combination of factors such as income, education level, occupation, and social status. SES is often used as a measure to understand and analyze disparities in access to resources, opportunities, and overall well-being among different segments of the population. It can influence various aspects of life, including health outcomes, educational attainment, and economic stability.

SES typically encompasses several interrelated components: (a) income (earnings from employment, investments, and other resources flowing over time); (b) education (level of schooling completed, additional training, or degrees obtained); (c) occupation (type of work an individual or household engages in, job title, responsibilities); (d) wealth (accumulated property, savings, investments, and other valuable possessions); (e) housing quality and stability; (f) neighborhood characteristics (e.g., safety, amenities, access to services); (g) access to resources (e.g., healthcare, transportation, nutrition, education); and (h) social capital (i.e., networks, relationships, and connections within their communities). These components are interconnected and interdependent and can vary depending on cultural context, geographic location, and individual circumstances.

Studies from different Majority and Minority countries (Kahn et al., 2022) on how socioeconomic deprivations are related to neurocognitive development mainly use measures based on the criteria of income, parental education, and occupation. Examples of these measures are (a) the Hollingstead scale, which combines income, parental education, and occupation, (b) the need-to-income ratio, determined by a national income threshold, and (c) indicators of structural deprivation (e.g., unsatisfied basic needs), which refer to parental education and occupation, safety of the dwelling, overcrowding, sanitation, availability of drinking water and assistance of children to school, among others.

Deprivation and neurocognitive outcomes

Several neuroscientific studies explored the associations between different SES components, brain structure and function, and cognitive and academic performances (Farah, 2017; Johnson et al., 2016; Rakesh & Whittle, 2021). These studies showed that parental education and family income separately accounted for individual variation in independent characteristics of brain networks considered critical for language, memory, and cognitive development. In one of the first studies of this type, which implemented a cross-sectional design, researchers found that family income was logarithmically associated with the brain surface area, in a way that small differences in income of the poorest individuals were associated with relatively large differences in surface areas. At the same time, in children from high-income families, similar income increments were associated with smaller differences in surface areas. Thus, income was more strongly related to brain structure in children from low-income families. Interestingly, parental education was linearly associated with brain surface areas, so increments in the number of school years completed were associated with increments in surface areas. Beyond the design limitations to support causal relationships, the importance of these findings is that different aspects of SES seem to be related in different ways to brain structural and functional development (Noble et al., 2015). In another longitudinal study Hair and colleagues (2015) found that developmental differences in the frontal and temporal lobes explained between 15% and 20% of children's academic achievement in those from low-SES homes. A more recent study implemented with adults showed that years of education and income were positively associated with grey matter volume in the anterior cingulate cortex -related to cognitive control processing- and hippocampus/amygdala -related to emotional, learning, and memory processing-,

respectively (Lotze et al., 2020). These findings support the hypothesis of differences in specific brain regions rather than differences in the overall brain and address the importance of supporting the efforts aimed at disentangling specific causal mechanisms.

Income, education, occupation, and other aspects of family functioning and parenting are also characterized by the overlapping of different dynamics of temporal change. Several studies have shown that the duration and developmental timing of socioeconomic deprivation showed that chronic exposure to low-SES conditions can be associated with lower quality of home environments, lower language and cognitive performance, and more externalizing and internalizing behaviors (e.g., Hackman et al., 2015, Najman, 2009; NICHD, 2005; Zachrisson & Dearing, 2015). These studies support the notion that the impact of socioeconomic deprivation on cognitive and academic performance is related to the timing, sequence, and duration of exposure to deprivations.

Issues of measurement and interactions

Neurocognitive outcomes associated with one or a combination of a set of SES components are not necessarily the same, nor do they consider the interdependence of factors at different levels of organization (e.g., neural, cognitive, behavioral) nor the temporal variations in the experience of childhood socioeconomic deprivation. Because neurocognitive development is based on the complex interaction and integration of multiple biological, psychological, social, and cultural factors, the associations between different SES components and emotional and cognitive processes during development are also complex and require an adequate research approach that can transcend the level of correlation (Duncan & Magnusson, 2012; Duncan et al., 2017; Lipina, 2017). The use of approaches based on the implementation of income, parental education, and occupation do not sufficiently address this complex factor dynamic of exposure at different levels of organization and cognitive performance during different stages of development.

With respect to the variability of neurocognitive outcomes depending on diverse SES components, Duncan and Magnusson (2012, 2017) argue for the importance of considering the differential influence of them, because each one represents a different resource that could be associated with neurocognitive development in distinct ways. For instance, family income could be volatile across a family's life cycle, due to changes in parental employment or family structure, which implies that different children from the same or different families could be exposed to different income levels during their development. In addition, the monetary satisfaction of children's nutritional and educational needs is not necessarily homogeneous among and within families exposed to socioeconomic deprivations (i.e., parents or caregivers vary with respect to how they spend their money resources to purchase food, so that children from the same or different families may receive different types of food based on such decisions) (Minujin et al., 2006).

Regarding the specific associations between changes in family income and neurocognitive development, few studies have been able to implement appropriate designs that allowed for the manipulation of SES components as independent variables. These studies showed that the increase in household income can be associated with increased academic performance (e.g., Duncan, Morris, & Rodrigues, 2011; Peng et al., 2019; Selvitopu & Kaya, 2023; Waters et al., 2021), and brain structure and function (Troller-Renfree et al., 2022). More studies of this type are necessary to explore the causal relationships of these associations, which remain unclear.

Higher parental education and occupation have been related to more nurturing parenting practices that in turn have been associated with better children's cognitive and academic outcomes during the first two decades of life (Bradley & Corwyn, 2002; Hackman et al., 2022; Jensen et al., 2017; Yoshikawa et al., 2012). However, the correlation between the level of parental education and children's cognitive and school achievement could also be the result of the combination of parental individual characteristics, and children's differences in temperament and susceptibility to the environment (e.g., Lecheile et al., 2020). In addition, parental occupation can be affected by dynamic transitions during the families' life cycles, which in turn can affect in different ways parental skills and lifestyles, including parenting practices aimed at fostering children's learning and cognitive skills. This implies that the SES components interact in a diverse way with individual and contextual aspects of children and their caregivers, which in turn contributes to the generation of different trajectories of neurocognitive development. In other words, there would be no homogeneous or universal impacts, even for children living in the same family.

In any case, the causal relationships of these associations remain unclear. As in the case of income, parental education and occupation are multifactorial constructs that involve many individual and environmental factors that have not been explored enough in terms of disentangling the potential causal mechanisms of each one. Thus, the traditional (i.e., income, parental

education, and occupation) are still insufficient because do not consider simultaneously how the duration, timing, and sequencing of socioeconomic deprivation during childhood influences outcomes in later stages of development. Instead of the indicator-based approach, some researchers propose to explore a latent-class one, which would allow testing more adequately the theories that emphasize the importance of the temporal dynamics of deprivation (e.g., if the duration of exposure to poverty is more significant than timing or sequencing) (e.g., Wagmiller, 2015).

Future directions

The challenge of improving our understanding of what aspects of childhood exposure to multiple socioeconomic deprivations influence the different attributes of neurocognitive development requires the building of an interdisciplinary agenda that could progressively involve conceptual, methodological, and technical innovations. In this respect, ecological and transactional considerations in child development and determinants should contribute to building a research agenda with the following aspects:

(a) Identifying protective and risk factors at different levels of organization (e.g., physiological, cognitive, behavioral, social, cultural), and in distinct developmental contexts (i.e., home, school, community).

(b) Analyzing the associations between different SES indicators, their experiential implications for children, and the complex set of involved mediators.

(c) Updating the study of the associations between SES and neurocognitive development considering that SES components may vary over time (e.g., progressive increase in the number of years of maternal education due to increased access to education in different countries).

(d) Guiding the design of interventions and policies in terms of different systems and dimensions involved in the components and processes that characterize neurocognitive development.

(e) Promoting financial priorities for government agencies and philanthropic foundations that support both basic and applied interdisciplinary research in child development.

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