

Poverty reduction and the developing brain

Katherine Magnuson, *UW- Madison*

Greg J. Duncan, *UC Irvine*

Hirokazu Yoshikawa, *Harvard University*

Lisa Gennetian, *National Bureau of Economic Research*

Kimberly Noble, *Columbia University*

Nathan Fox, *University of Maryland*

Charles Nelson, *Harvard University*

A growing body of small-scale studies documents that the cognitive and brain development of low-income children differs from that of children reared in higher-income families. Differences favouring more affluent children are found for young children's language, memory, executive function, and socioemotional processing, with corresponding differences in neural structure and function in brain regions that support these skills.¹ At the same time, a large body of social science research, including quasi-experimental designs, documents income disparities in more general measures of children's achievement, school performance, and learning-related behaviors such as attention and self-regulation.² Developmental scientists agree that poverty is especially likely to shape children's early development because of the high plasticity and rapid growth of the brain during the first three years of life. Yet, there has not been a rigorous study of how income supports for families affect the brain function and development of infants and toddlers.

We propose the first randomized experiment testing causal connections between poverty reduction and brain development among very young children. We will randomly assign some 1,000 low-income mothers and their newborns in several ethnically and geographically diverse communities to either (1) an experimental group that receives \$333 in cash payments each month (\$4,000 each year) for each of the first three years of the children's lives, with the first payments occurring shortly after the baby's birth, or (2) a control group that receives much smaller payments (\$20 per month). Recent research suggests that the \$3,760 annual difference is large enough to produce meaningful differences in children's cognitive development. We will also test variations in the frequency of payments to low-income families, a critical policy dimension in U.S. income support policy that could have consequences for families' economic stability.

Moreover, to understand how poverty reduction improves brain functioning, at ages one and two we will measure family context that we expect links poverty to development: family expenditures, routines and time use, parent stress and parenting practices, and child care arrangements. Rigorous laboratory measures of children's cognitive and brain development, as well as measures of health and behavior, will be gathered at age three.

Results would provide strong and clear evidence about the magnitude and pathways of causal connections between poverty reduction and early cognitive and brain development. Beyond its core contributions to science, the proposed project will provide important evidence about the likely effects of tax and income-enhancement policies for young children, such as the Child and Earned Income Tax Credits, incentive-based employment programs, and related social policies designed to enhance family economic well-being.

With grants from the Annie E. Casey Foundation and Jacobs Foundation, we are finalizing the details of our proposed research plan and are planning to launch a one-year pilot study in January, 2014. We are seeking support from a consortium of private foundations and government agencies that would enable us to begin the multi-site project in the spring of 2015.

For additional information about this project please contact Katherine Magnuson (kmagnuson@wisc.edu) or Kimberly Noble (kgn2106@columbia.edu)

SOME DETAILS

Who we are

Neuroscientists: Kimberly Noble, MD, PhD; Nathan Fox, PhD; Charles Nelson, PhD

Social scientists: Katherine Magnuson, PhD; Greg J. Duncan, PhD; Lisa Gennetian, PhD, Hirokazu Yoshikawa, PhD

Collectively, our expertise spans neuroscience, economics, and developmental psychology. Four of us hold chaired and/or distinguished professorships at leading research universities. All but one of us has extensive experience with experimental studies (e.g., the Bucharest Early Adoption Study; Moving to Opportunity; the welfare-to-work experiments conducted by MDRC in the 1990s; the *Un Buen Comienzo* preschool experiment in Chile). Several of us have directed large longitudinal data collection projects (e.g., the Panel Study of Income Dynamics). Several of us have written widely-cited studies of the neuroscience (Noble) and social science linkages between poverty and child development (Duncan and Magnuson). All of us have collaborated closely with one or more of the rest on major research projects.

What we would do

Some 1,000 infants born to mothers with low socioeconomic status (income no greater than approximately 125% of federal poverty thresholds) in up to 7 sites across the United States will be assigned at random to experimental or control groups. Experimental group parents would receive unconditioned cash payments of \$333 per month (\$4,000 per year) for three years, with the form of payment structured to be maximally beneficial for meeting the economic needs of low-income families. The comparison group would receive a nominal payment-- \$20 per month, delivered in the same ways. Following standard research procedures, all participating families would receive a \$100 respondent incentive for participating in three of our four planned interviews and a \$200 payment for our proposed age-3 laboratory assessments. At this point, prospective sites include the following:

Columbia University Medical Center/ New York-Presbyterian Hospital, New York City	South Carolina Medical Center, Columbia, South Carolina
Harvard Medical School/Boston Children's Hospital, Boston	UW-Milwaukee & Marquette University, Milwaukee
Dept. of Human Development, University of Maryland Tulane Medical Center, New Orleans	UC Irvine Medical Center, Orange, CA

We anticipate that for logistical reasons, ultimately the study will be fielded in only a subset of proposed sites. Mothers will be recruited in maternity wards of participating hospitals shortly after giving birth and, after consenting, will be administered a 20-minute baseline interview. The three follow-up waves of data collection will provide information about family functioning as well as developmentally appropriate measures of children's cognitive and behavioral development. We will collect information from the mother on the phone when the infant is 12 months old and in the home from the mother and child at the children's second birthday. At age 3, mothers and children will be assessed and interviewed in research laboratories at each site. We will seek consent from mothers to collect state and local administrative data that will shed light on several relevant domains of child and family wellbeing, including parental employment, utilization of public benefits such as Medicaid and Supplemental Nutrition Assistance Programs (SNAP), and any involvement in child protective services. Such consent will also include the option to obtain relevant administrative data to measure long-term outcomes including student-level school records when children become of school age.

The compensation difference between families in the experimental and control groups would boost family incomes by \$3,760 per year, an amount shown in economics and developmental psychology to be associated with socially significant and policy relevant improvements in children's school achievement. After accounting for likely attrition, our total sample size of 800 at age 3 years, evenly divided between experimental and control groups, provides ample statistical power to detect meaningful (.20 sd – the equivalent of 3 IQ points) differences in cognitive functioning, and key dimensions of family context.

Cognitive measures at age 3

To date, direct studies of the effects of poverty on brain development are scarce. However, recent studies by our team and others have reported correlations between poverty and brain structure/function in several neural regions that support language, memory, executive function and socioemotional skills.^{3,4} In this experimental study, we will build on these prior correlational studies to test whether such associations are causal.

At the age-three lab visit we will administer validated, reliable and developmentally sensitive measures of language, memory, executive functioning and socioemotional skills selected from the NIH Toolbox. We will also collect direct measures of young children's brain development. A core feature of brain development, reflected in brain function, is the development of brain circuitry. Our ability to use language, for example, depends critically on communication between select regions of the brain. Electroencephalography (EEG) is particularly well-suited to studying the emergence of these connections in early childhood. Our team and others have used EEG to show that this developing circuitry is associated with cognitive and verbal abilities in young children. We hypothesize that poverty reduction will result in more optimal development of this circuitry, and that this process will explain a substantial portion of the link between income and language ability.

Similarly, the development of brain architecture in the first years of life is crucial for later learning and adaptive social behavior. Our team and others have shown that children reared in adverse conditions show atypical levels of brain activity. Importantly, reducing adversity can partially normalize these patterns. Early adversity has particularly important effects on the neural circuits that support memory, executive function and socioemotional processing. We therefore hypothesize that poverty reduction will lead to more optimal brain activity patterns, and that these EEG variables will explain the links between income and these cognitive skills.

Family processes that facilitate brain development

If family poverty reduction shapes early brain development and cognitive functioning, it is important to identify the family processes that help pave the way. Social scientists have studied two complementary pathways by which low family incomes shape the context of child rearing. First, additional resources enable parents to buy goods and services for their families and children that support cognitive development (see Figure 1). These include higher quality housing, nutrition and non-parental child care; more cognitively stimulating home environments and learning opportunities outside of the home; and, by reducing or restructuring work hours, more parental time spent with children. These environmental enrichments may improve children's cognitive functioning, in particular language skills and IQ, by increasing the connectivity and coherence of neural networks. Measures of these features of the child's environment will be collected during the in-home interview when the child is 2 years old.

A second pathway is that additional economic resources may reduce parents' own stress and improve their mental health (see Figure 2). This may allow parents to devote more positive attention to their children, thus providing a more predictable family life, less conflicted relationships, and warmer and more responsive interactions. Research suggests that warm and responsive caregivers are able to help children regulate their stress responses, thereby reducing the likelihood that children experience the kind of prolonged activation of their stress response systems that has been linked to compromised neural development in the areas of the brain that affects memory, executive functioning, and socioemotional processing. Measures of maternal stress and mental health will be collected at ages 1 and 2.

Connections to policy

As an unconditional cash transfer, our income support "treatment" most resembles European-style child allowances and the U.S. child tax credit. But findings from our project will help inform policy proposals that would change benefit levels in a host of federal and state programs. The Earned Income Tax Credit conditions its payment on earnings, but can transfer as much as \$6,000 per year to low-income families. SNAP requires that its payment be used for food purchases, but effectively boosts family income by as much as \$8,000. TANF benefits are conditioned on various state-directed rules and amount to about \$5,000 in a typical state. Housing Choice Vouchers are directed toward rent payments, and typically provide the equivalent of \$7,500 per year.

The benefit levels and coverage of almost all of these programs are fiercely debated in today's budget battles. Virtually absent from these debates is evidence on the consequences of proposed changes for the healthy development of young children, because the needed studies have not been done. Advocates who claim that poverty hurts children are countered by other advocates who say "it's not poverty, it's 'single-parent families,' or 'character'" or any number of other alternative explanations. Our study's \$4,000 annual payment is within the range of benefit and coverage changes being debated for these kinds of programs and also consistent with the income changes that research studies suggest would produce changes in children's cognitive development and health. Thus, our study will be the first to provide definitive evidence on the extent to which young children's cognitive development and health is affected by income reductions or enhanced by income increases—or whether income itself does not matter at all.

Timeline

We propose a five-year plan of work for the main study, with a small pilot study occurring in the year before the main multi-site study begins, as described below. The first six months of the main multi-site study will involve planning for data collection. The 1,000 mothers and infants will be recruited between months 7 and 18 of the main project period. Between months 19 and 31, recruited infants would be celebrating their first birthdays, at which time we will conduct telephone interviews with their mothers. In-home interviews timed to children's second birthdays will take place over months 32 to 43 of the project. Third-birthday lab visits would take place between months 44 and 55. Analyses would begin with partial data from the lab assessments during months 49 to 55 and would be completed by the end of the 60th month. We are eager to follow the sample beyond the children's third birthdays, providing we collect meaningful impacts on child and family functioning. We anticipate that administrative data, including information on school achievement, will be especially useful in any follow-up initiative. Finally, we are also interested in the public good that may result from this project – accordingly, we plan

to issue a public-use data file 12 to 15 months following the completion of our third-birthday laboratory-based data collection

We are very pleased that a grant from the Jacobs Foundation will fund a pilot study in our New York site. We will begin the pilot study in January, 2014 so that its lessons can be incorporated into our research proposals. This pilot would involve recruiting 25 new mothers shortly after the birth of their babies and follow them through our planned 12-month interview. Procedures in the pilot study will mimic those we intend to use in the main study: i) mothers would be randomly assigned to treatment and control groups and promised 12 months (as opposed to 36 months) of payments in the form of debit cards; ii) we would ask mothers for their consent to access all of the administrative data (e.g., earnings and transfer income records) planned for the main study; iii) we would include a modest qualitative component involving periodic contact with the families to get a feel for how they are using their debit cards.

Budget and Next Steps

We are still working out the budget details for our costly project. Respondent payments alone will approach \$7 million if we are able to maintain contact with all of our respondents. Direct costs for the survey work sum to roughly \$3.5 million. We estimate that the direct costs of lab visits, time of PIs and staff, travel and other project-related expenses will sum to an additional roughly \$3 million over the course of the five project years.

It will be important to have available the full \$7 million in subject payments when we enroll mothers in the study, so we will need at least \$10 million in committed funding to cover payments and research costs at the start of the project. The actual funding can stretch out over the course of the project, but the \$10 million in committed funds need to be in place at the start.

We have made considerable progress in planning and funding for our project. A grant from the Annie E. Casey Foundation has enabled us to hire Ruth Friedman to resolve the “clawback” issues in federal and state programs. In brief, if programs like SNAP and HUD’s Housing Choice Vouchers count our \$4,000 payment as income for the determination of benefits, then the increase to family *net* income could be much smaller than \$4,000. We will determine ways to ensure that little or none of our cash payments will be offset by reductions in public program benefits.

We have developed a rough timeline to move the project forward:

- *July, 2013 through February, 2014*: develop a consortium of foundations to generate letters of intent to fund the bulk of the \$7 million cash payments we will need during the years of the experiment (roughly calendar years 2015-2017).
- *January 2014-June 2014*: Develop and submit proposals to various federal government agencies for funding the expected \$8 million in research expenses that will be incurred between 2015 and 2019. The largest of these grant proposals will be submitted to NICHD. We plan to deliver the needed pre-proposal materials (mainly budgets and foundation letters of intent) to them in February, 2014 in anticipation of a formal proposal submission in June, 2014.
- *Winter, 2015*: Preliminary work begins in all study sites in anticipation of the beginning of data collection.
- *Spring, 2015*: Recruiting begins in all study sites.

Figure 1: Enrichment pathways model

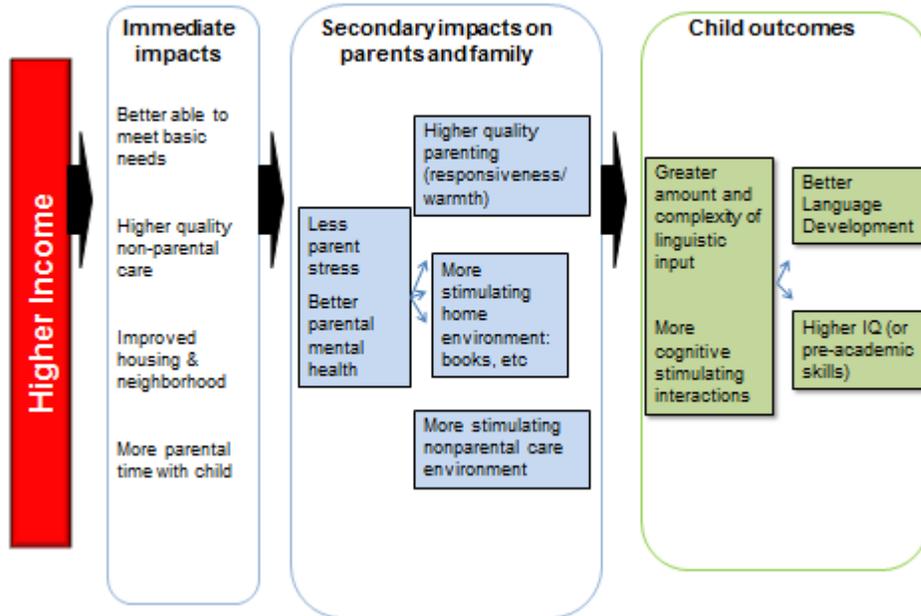
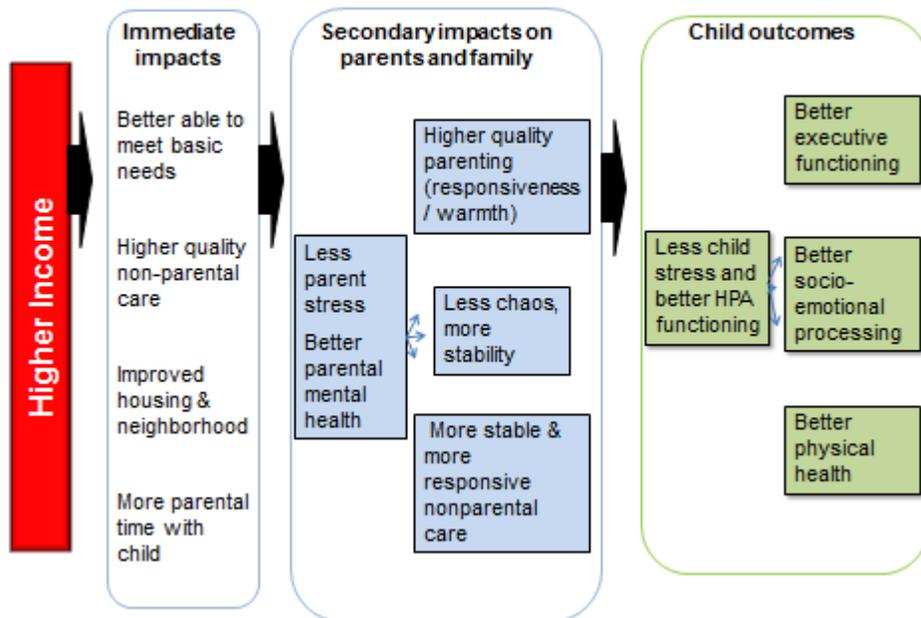


Figure 2: Stress pathways model



ENDNOTES

¹ Duncan G and Magnuson K, (2012) "Socioeconomic status and cognitive functioning: Moving from correlation to causation" *Wiley Interdisciplinary Reviews: Cognitive Science*, 3:377–386.

² Akee R, Copeland W, Keeler G, Angold A, and Costello J (2010). "Parents' incomes and children's outcomes: A quasi-experiment." *American Economic Journal: Applied Economics* 2010, 2(1):86–115; Dahl, G. B. & Lochner, L. (2012). "The impact of family income on child achievement: Evidence from the Earned Income Tax Credit," *American Economic Review*, 102(5): 1927-56; Duncan GJ, Morris PA, Rodrigues C. (2011). "Does money really matter? Estimating impacts of family income on young children's achievement with data from random-assignment experiments." *Developmental Psychology*, 47(5):1263–1279.

³ Noble, K. G., et al. (2012). "Neural correlates of socioeconomic status in the developing human brain." *Developmental Science*, 15(4): 516-527; Stevens, C., et al. (2009). "Differences in the neural mechanisms of selective attention in children from different socioeconomic backgrounds: an event-related brain potential study." *Developmental Science*, 12(4): 634-646., Hanson, J. L., et al. (2011). "Association between income and the hippocampus." *PLoS ONE*, 6(5): e18712., Jednoróg, K., et al. (2012). "The influence of socioeconomic status on children's brain structure." *PLoS ONE* 7(8): e42486.

⁴ Structural or functional magnetic resonance imaging (s/fMRI) has far greater spatial resolution than EEG. However, EEG measures are particularly well suited to studying neural processes in toddlers, as, unlike MRI, they do not require the young child to sit perfectly still in a dark and noisy tube, but rather, allow for the child to sit comfortably on the parent's lap. Further, the far greater expense of MRI compared to EEG would render the former unfeasible in a large study. If the poverty reduction intervention proposed here suggests meaningful impacts on child development, a natural future follow-up study will include assessing MRI on a subset of participants as children get older.