

## On-line Appendix

### **Early Childhood Education Meta-analytic data base**

The meta-analytic database used for Figure 2 is the product of the National Forum on Early Childhood Policy and Programs (<http://developingchild.harvard.edu/initiatives/forum/>) and was compiled under the direction of the authors, Holly Schindler and Hirokazu Yoshikawa . The Forum is housed at the Center for the Developing Child at Harvard University, which is directed by Jack Shonkoff. A multi-step data collection and evaluation process was used to determine what studies would be included in this database. The first step was to conduct a comprehensive search of the literature from 1960 to 2007, when the coding project began. The Forum was able to take advantage of another meta-analytic database compiled previously by Abt Associates, Inc. and the National Institute for Early Education Research (NIEER), which included early childhood intervention studies from 1960-2003 (Camilli et al., 2010; Jacob, Creps & Boulay, 2004; Layzer, Goodson, Bernstein & Price, 2001). This yielded 624 previously coded studies.

To search for additional studies, the Forum next conducted keyword searches in ERIC, PsycINFO, EconLit, and Dissertation Abstracts databases, resulting in 9,617 documents, as any given program may produce a series of such documents. It then manually searched the websites of policy institutes (e.g., RAND, Mathematica, NIEER) and state and federal departments (e.g., U.S. Department of Health and Human Services), as well as references mentioned in collected studies and other key early childhood education reviews. This search produced another 692 documents. In sum, 10,309 documents for potential inclusion in the early childhood education portion of the database were identified.

The vast majority (91%) of the 10,309 documents were excluded because they violated at least one of the inclusion criteria. Most of the excluded documents were not actual research studies but rather commentaries or reviews. Others were eliminated because of methodological shortcomings, because they were not clear about the selection process for participants in the study, or because their interventions took place outside of the United States. The resulting database includes studies of programs or interventions for children between birth and age 5.

The Forum next developed criteria for the inclusion of studies into its meta-analytic database. In addition to the requirement that they examine an early childhood education intervention or program reported on from 1960 to 2007, studies had to have a treatment and control/comparison group, rather than simply assessing the growth of one group of children over time. Each of the groups in the study had to have included at least 10 participants and incurred less than 50% attrition. Studies were excluded if they were testing a pharmacological agent, assessed children with medical disorders or learning disabilities, or tested the effectiveness of medical procedures or health-related products.

Figure 2 focuses exclusively on treatment effects from early childhood education programs, defined as structured, center-based early childhood education classes, day care with some educational component, or center-based child care. These include full pre-school programs such as Head Start and other interventions conducted by researchers. Programs included were required to have provided services to children, their families, or staff at the program sites, and assessed program impacts on children's cognitive and achievement outcomes.

About one-third of the ECE studies used random assignment with the remainder following quasi-experimental designs such as change models, individual or family fixed effects models, regression discontinuity, difference in difference, propensity score matching, interrupted

time series, instrumental variables and some other types of matching. Studies that used quasi-experimental designs must have had pre- and post-test information on the outcome or established baseline equivalence of groups on demographic characteristics determined by a joint test.

A team of nine graduate research assistants at three universities (Harvard, UC Irvine, and University of Wisconsin-Madison) were trained as coders during a 3- to 6-month process that included instruction in evaluation methods, using the coding protocol, and computing effect sizes. Trainees were paired with experienced coders in multiple rounds of practice coding. Before coding independently, research assistants also passed a reliability test comprised of randomly selected codes from a randomly selected study. In order to pass the reliability test, research assistants had to calculate 100% of the effect sizes correctly and achieve 80% agreement with a master coder for the remaining codes. In instances when research assistants were just under the threshold for effect sizes, but were reliable on the remaining codes, they underwent additional effect size training before coding independently and were subject to periodic checks during their transition. Questions about coding were resolved in weekly research team conference calls usually involving all four principal investigators, and decisions were kept in an annotated codebook so that decisions about ambiguities could be recalled when coding subsequent studies. In a few instances, codes were added and previously coded studies were adjusted accordingly to account for the new additions.

Each study's outcome measures were coded into standardized mean difference effect sizes, which were computed using the Comprehensive Meta-Analysis computer software program (Borenstein, Hedges, Higgins, & Rothstein, 2005). We used the Hedges' *g*-based definition of effect sizes, which adjusts standardized mean differences (Cohen's *d*) to account for bias arising from small sample sizes.

Data for Figure 2 come from the 84 programs that assessed cognitive and/or achievement outcomes around the end of their treatments and used no-program control groups. So, for example, early childhood education programs that tested a version of a classroom-based program that included home visitation vs. the classroom program that did not include home visitation are not included in the figure.

Operationally, we choose effects sizes closest to the end of treatments but defined the end of treatment interval to include effect sizes measured as late as one year following the completion of the program and as early as 75% of the length of the program. All available effect sizes for cognitive or achievement measures at the point closest to the end of treatment are included in the analysis.

The effect sizes shown in Figure 2 and in the Appendix Table are simple means of all effect size estimates for cognitive and achievement outcomes for each given program. Bubbles areas are proportional to the inverse of squared standard errors of the average estimates, which is calculated by a Bayesian shrinkage model to take sampling variation of the within-study estimates into account. The inverse of standard error squared is also used to weight the trend line shown in Figure 2. To avoid sensitivity to extremely large variance weights, weight values are truncated from above at 100, which corresponds to standard errors on treatment effect estimates of .10 standard deviations.

The effect sizes shown in Figure 2 are estimates and therefore subject to sampling variation. Estimating their variability with a random effects model or with a Bayesian shrinkage estimator reduces the standard deviation across all study-average effects sizes by nearly 50%.

Appendix Table 1. Data Used in Figure 2

<b>Program name</b>	<b>Starting year</b>	<b>Average effect size at end-of-program</b>	<b>1 / Study level standard-error squared</b>	<b>Head Start=1</b>
Evaluation of the effect of Head Start program on cognitive growth of disadvantaged children	1963	0.54	15.13	1
National Head Start and Summer Head Start program, 1965-1968	1965	0.10	53.46	1
Summer Head Start in Kearney, NE	1965	0.08	6.08	1
Summer Head Start in San Jose, CA	1965	0.42	14.34	1
Summer Head Start in Cambridge, MA	1965	0.14	11.03	1
Head Start in Miami, FL	1965	0.79	9.63	1
Summer Head Start in Duluth, MN	1965	0.38	14.93	1
Impact of 1965 Summer Head Start on children's concept attainment by Allerhand	1965	0.46	13.28	1
Summer Head Start in Lincoln, NE, matched pairs	1965	0.03	71.07	1
Summer Head Start in Lincoln, NE, unmatched pairs	1965	-0.06	3.04	1
Bicultural preschool programmed Head Start	1966	0.74	6.29	1
Summer Head Start in Washington, DC	1966	-0.07	35.40	1
Head Start effects on children's behavior and cognitive functioning one year later by Nummedal and Stern	1967	-0.13	13.50	1
Experiments in Head Start and early education: Direct instruction in Head Start vs. No preschool	1968	0.47	12.14	1
Experiments in Head Start and early education: Enrichment in Head Start vs. No preschool	1968	0.40	13.25	1
Head Start in rural areas, MN	1968	0.70	15.93	1
Comparison of children enrolled in Head start or no preschool in two cities	1969	0.33	93.45	1
Planned Variation in Head Start, Head Start with curricula vs. no Head Start	1969	0.32	10.13	1
Planned Variation in Head Start, standard Head Start vs. no Head Start	1969	0.27	23.96	1
Head Start in New Haven, CT	1971	0.55	12.91	1
Head Start in New Haven, CT	1971	0.39	25.94	1
Head Start Bilingual Bicultural Development Project, bilingual Head Start vs. Stay at home	1979	0.29	16.18	1
Head Start Bilingual Bicultural Development Project, standard Head Start vs. Stay at home	1979	0.33	6.99	1
Head Start in New Haven, CT	1979	0.55	17.33	1
Head Start in Guam	1985	0.02	19.95	1
Early Head Start Research and Evaluation Project	1996	0.13	100.00	1
ECLS-K Head Start Study, white	1997	-0.06	100.00	1
ECLS-K Head Start Study, African-American	1997	0.05	100.00	1
ECLS-K Head Start Study, Hispanic	1997	-0.04	39.42	1
Southeastern Head Start program of high quality	1998	0.35	24.43	1
National Head Start Impact Study First Year, 3-year-old cohort	2002	0.26	47.99	1
National Head Start Impact Study First Year, 4-year-old cohort	2002	0.25	100.00	1
NYC Early Head Start, 12 months of younger	2002	-0.34	1.30	1

NYC Early Head Start, older than 12 months	2002	0.23	0.61	1
Early Training Project	1962	1.04	8.47	0
Preschool intervention with disadvantaged children in early 1960s Cambridge, Pre-k & responsive environments	1962	-0.01	11.42	0
Preschool intervention with disadvantaged children in early 1960s Cambridge, Pre-k	1962	0.14	9.36	0
Preschool intervention with disadvantaged children in early 1960s Cambridge, responsive environments	1962	0.00	8.72	0
The Perry Preschool	1962	1.10	9.23	0
Howard University Preschool Program	1964	0.47	20.41	0
6-month Full-Day Preschool for 3- to 4-year-olds with curriculum emphasis on language, social skills, & health	1964	0.74	10.38	0
Karnes Ameliorative Curriculum Pre-K	1965	1.60	1.35	0
NY Pre-K for disadvantaged children	1965	0.08	100.00	0
Preschool in Fremont, CA	1966	-0.19	7.29	0
Urbana Infant Home Tutoring Program	1966	1.10	6.40	0
Greensboro Demonstration Nursery Center	1967	0.81	7.29	0
Project Know-How	1967	0.65	13.16	0
Yale Child Welfare Research Program	1968	1.22	7.88	0
Home Oriented Preschool Education, TV & Home visit & Mobile classroom vs. control	1968	0.15	2.88	0
Home Oriented Preschool Education, TV & Home visit & Early childhood classroom vs. control, 1969	1968	0.38	6.20	0
Home Oriented Preschool Education, TV & Home visit & Early childhood classroom vs. control, 1970	1968	0.67	5.53	0
Syracuse University Family Development & Research	1969	0.46	100.00	0
Abecedarian Project	1972	0.90	16.47	0
Pittsfield, MA Parent-Child Home Program, 1978	1974	0.36	16.41	0
Pittsfield, MA Parent-Child Home Program, 1983	1974	0.86	8.35	0
Infants in community-based day care	1976	0.39	1.34	0
Project CARE	1978	0.44	4.27	0
Field Teacher Mother Parent Training	1979	0.62	17.29	0
BYU Pre-school program effects on Low-Risk Children	1980	0.48	18.09	0
Child care from infancy to 3 years of age	1981	0.01	5.71	0
Children of Poverty: A multi-level analysis of the determinants of intellectual development	1983	0.74	29.98	0
Infant Health and Development Program	1984	0.26	76.74	0
Chicago Parent Center	1985	0.17	93.85	0
Even Start National Evaluation	1991	0.04	27.13	0
North Carolina Pre-K Evaluation, Chapter 1 preschool	1991	0.10	47.52	0
North Carolina Pre-K Evaluation, Family-focused preschool	1991	0.13	18.29	0
North Carolina Pre-K Evaluation, Community daycare	1991	0.49	20.06	0
Comprehensive Child Development Program	1991	0.03	100.00	0
The NICHD Study of Early Child Care and Youth Development	1991	0.20	100.00	0
Kentucky Educational Reform Act (KERA) Preschool Program, cohort 1	1992	0.22	79.58	0
Kentucky Educational Reform Act (KERA) Preschool Program, cohort 3	1992	0.11	63.45	0

Georgia Pre-K Program	1993	0.23	53.98	0
Michigan School Readiness Program Longitudinal Evaluation	1995	0.25	52.17	0
Charlotte Bright Beginnings Pre-K Evaluation	1997	0.29	100.00	0
Center-based language intervention program	1997	1.09	2.99	0
Parent-child intervention for depressed mothers	1997	0.43	20.57	0
Literature-Math-Scaffolding Intervention	1998	0.26	14.83	0
Third Even Start evaluation	1999	-0.19	38.91	0
Utah Pre-K Kindergarten Readiness Program	2003	0.16	43.92	0
Five State Pre-K RD Evaluation, Michigan	2004	0.13	100.00	0
Five State Pre-K RD Evaluation, New Jersey	2004	0.09	100.00	0
Five State Pre-K RD Evaluation, Kolahoma	2004	0.14	100.00	0
Five State Pre-K RD Evaluation, South Carolina	2004	0.14	100.00	0
Five State Pre-K RD Evaluation, West Virginia	2004	0.15	100.00	0

**Appendix References** (\* indicates that the study contributed data to Figure 2)

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