First Inaugural Conference

Early Childhood Interventions Network
Human Capital and Economic Opportunity Global Working Group
Organized by James J. Heckman, Richard Tremblay, Burton Singer Seong Hyeok Moon, Rodrigo Pinto

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Swift Hall
University of Chicago
1025 E. 58th Street, Chicago, IL 60637
Conference Report

I.   Introduction

A.   Welcoming Remarks by James J. Heckman

The Institute for New Economic Thinking Early Childhood Intervention Working Group (ECI) is convening for the first time as a part of the Human Capital and Economic Opportunity Working Group within The Institute for New Economic Thinking.

The Institute for New Economic Thinking and the Human Capital and Economic Opportunity Working Group aim to open economics to many different perspectives and create a network to study the "determinants of human flourishing" as outlined in the capabilities literature, which goes beyond traditional human capital models. To accomplish these goals, the Human Capital and Economic Opportunity Working Group is organizing conferences to promote understanding, establishing summer schools to introduce students to new economic reasoning and a wide range of professors, and integrating macro- and micro-economic literature, financial and human capital markets, and theoretical and practical policy. As part of this process, the Human Capital and Economic Opportunity Working Group will put out a monograph series on human flourishing in the 21st Century.

As a part of the Human Capital and Economic Opportunity Working Group, the goals of ECI are to investigate the early origins of inequality and their lifetime consequences, and to study the provision of equality of opportunity from birth. Leading ECI are Burton Singer, James Heckman, Richard Tremblay, Seong Moon, and Rodrigo Pinto. They believe that the study of early childhood interventions can lead to equality and justice. To accomplish its goals, ECI encourages non-economists, young investigators, and those out of the mainstream who are not just promoting the standard lines to challenge and renew economic thought.

B.   Introductory Remarks by Steven N. Durlauf

The Human Capital and Economic Opportunity Working Group initiative is very ambitious. The breakdown of barriers and representation of a range of disciplines is not standard procedure in social science. However, early childhood research has the ability to change the way we think about inequality and justice.

C.   Introductory Remarks by Moderator Burton H. Singer

At this conference, ECI focuses on the theoretical and practical aspects of early childhood interventions. In terms of theory, important questions about methodology and the evaluation of early childhood interventions will be discussed. In terms of practice, some methods being used and those using them will be introduced.

II.   Session 1: Strengthening Methodology

A.   "Studying The Impact of Program Participation in Multi-Site Trials Using Instrumental Variables." Stephen Raudenbush (University of Chicago).

Multi-Site randomized control trials of program participation that include replications of experiments at multiple sites have become increasingly popular in education research. Of 130 large randomized control

trials of education done in the last 10 years, about 75% have been implemented at multiple sites. These multi-site trials could allow researchers to model not only the average effect of program participation but also heterogeneity across sites and multiple mediators. In an IV setting, this can be done by implementing random coefficient models under certain assumptions. The model and necessary assumptions were reviewed and future possibilities discussed. This method has great potential for analyzing the Head Start Impact Study, and is described here in the context of curricular reform in Chicago.

The random coefficient model implemented is a person-specific causal model where the average effect of being assigned treatment is the product of the average effect of assignment on participating and the effect of participation on the outcome. The typical assumptions that apply to the single site instrumental variable case are maintained. Additionally, SUTVA and the Exclusion Restriction are imposed within sites. We also assume monotonicity for the effects of assignment and effects of treatment, rather than assuming that they are uncorrelated across sites. There are two ways to approach the technical estimation, both of which were described in detail in the paper presented at the conference.

When this method is applied to the analysis of curricular reform in Chicago, it allows two mediators to be revealed and variations across sites to be examined. Participation in the treatment and the tracking (changes in peer ability composition) caused by the treatment are both found to be sources of the treatment effect, and compliance is shown to be a mediator of both. Because participation in the treatment and the tracking that is sometimes caused by the treatment appear to work in opposite directions, this is an important result.

There is interest in extending this model to either adjust for or estimate peer effects, and some preliminary work is being done.

Model 1 is a random coefficient model within each site, and site-specific estimates vary across sites. This model becomes 2SLS with single instrument and site fixed effects. Model 2 has stronger assumptions and is the generalization of the case of multiple mediators. This model becomes 2SLS with multiple instruments.

There are two examples such as 1997 Algebra for All in Chicago and Double-Dose Algebra. The first case shows a disappointing result but the second case shows good compliance. In conclusion, the reform enhanced math instruction for low-skill students and that helped a lot. Thus, we need to apply this to Head Start and enrich the modeling of mediators.

B.   "Getting SMART about Adapting Interventions.", Susan Murphy (University of Michigan)

Adaptive interventions are individually tailored sequences of interventions, where treatment type and dosage change in response to patient outcomes. These models are related to dynamic models used in economics and statistics. Whereas medical trials allow us to confirm the efficacy of interventions, adaptive interventions allow us to build and operationalize interventions in practice.

Adaptive interventions are appropriate in situations where there is:

1) High heterogeneity in response
2) Lack of adherence or excessive burden in common
3) A need to vary intensity of the treatment

Adaptive interventions are capable of revealing:

1) An optimal sequence of treatment(s)
2) An optimal timing of treatment alteration(s)

3) What information should be used to determine and individualize (1) and (2)

An adaptive drug court program for drug abusing offenders provides an example of an adaptive intervention. The goal of this program, run by the Doug Marlowe at UPenn, is to minimize recidivism and drug use. Treatment is tailored to the results of periodic assessments of risk and compliance.

A Sequential Multiple Assignment Randomized Trial (SMART) is a certain kind of adaptive intervention. Similar to factorial designs used in engineering, a SMART intervention is a multi-stage trial in which each stage corresponds to a critical clinical decision and a randomization. The goal of the trial is to inform the construction of adaptive intervention.

There are four principles of SMART studies.

1) Keep it simple: restrict scientific consideration and class of nest treatments.
2) Tracks over times
3) Choose primary hypotheses that are scientifically important and aid in developing the adaptive intervention
4) Conduct the secondary.

The Pelham ADHD study, which includes four very simple interventions, provides an example of a SMART intervention. Responders are divided into adherers and non-adherers and then treatment is assigned according to adherence status.

Greater treatment individualization is possible via Q-Learning, a method of analyzing the results of adaptive interventions. Q-Learning is similar to dynamic programming in that regressions of treatment effects are performed recursively at each stage of treatment assignment. Q-Learning for SMART studies is conducted by performing the regressions in reverse order, beginning with the final stage. Since the dependent variable for the regression in the prior stage is a prediction of the final response under optimal treatment in the final stage, the final stage regression is used to estimate the response to the optimal final stage treatment. The patterns that the regressions identify are the same; medication improves performance for children who were medicated before. From these regressions we get an adaptive treatment proposal: if medication has not been used in the prior year, then begin with behavioral modification, otherwise select either behavioral modification or medication. There are some issues with deriving confidence intervals for these results.

The major advantage of the adaptive intervention approach is its focus on non-adherence as an outcome. The method encourages researchers to think about non-adherence as an outcome that tells them about the treatment being offered, what might cause those assigned to refuse to comply, and how the treatment can be tailored to increase compliance.

C.   "Statistical and Econometric Issues in Evaluating Early Childhood Interventions," Rodrigo Pinto (University of Chicago)

Many social experiments try to measure the impact of early childhood investment on lifetime outcomes using randomized trials. In many cases treatment groups are well defined, treatment is uniform, samples are small, and the number of outcomes is large. However, compromised randomization is often the rule rather than the exception. Generally, the literature ignores compromised randomization. A permutation testing procedure tailored to this situation permits inference that takes account of compromised randomization and is appropriate in small samples.

To model these randomized trials, we can consider a directed acyclic graph (DAG) to represent a simplified Roy model. We suppose that we can separate the observed mediator into two parts, D, which is correlated with the unobserved variables that are independent of the outcome of interest, Y, and D' that is correlated

with unobserved variables that are not independent of the outcome of interest, Y. These variables are also related to X, the characteristics of the child and the family, which are related not only to outcomes but, in the case of compromised randomization, are also related to treatment. We require that the local Markov condition holds: variables are independent of all variables except their descendants conditional on their parents. We have then constructed a surrogate causal model for simplified Roy model, which separates the observed mediators into two parts.

Given this model, we can test the null hypothesis of no treatment effects by assuming exchangeability of Y and D given X. If you assume that the outcome is independent of the treatment conditional on observed characteristics and assume that treatment status, D is exchangeable. Under the null hypothesis of no treatment effects, the outcomes are independent of the assignment D conditioned on characteristics X, and exchangeability implies that Y and D have the same distribution conditional on X. Taking the variables that compromised randomization into account, we can classify participants as "always takers", "never takers", "compliers", and "defiers", and construct permutation orbits for permutation testing that are consistent with all possible randomization schemes. (Note: This procedure may not be possible when sequential randomization occurred.)

The method described here contributes to the development of a general method to evaluate treatment effects in small samples with compromised randomization. The use of a flexible causal framework is the key for examining the problem. The method described can be extended to include a multiple hypothesis testing procedure.

III.   Session 2: Measuring Vulnerabilities and Outcomes.

D.   "Fragile Families: Implications for Parenting and Child Well-Being," Jeanne -Gunn (Columbia University)

The percent of births to unmarried mothers in the United States has decreased dramatically to over 40%. This trend demands we ask the following questions:

1) What are the capabilities and circumstances of unmarried parents?
2) What is the nature of parental relationships at birth, and how do the relationships change over time?
3) How do family structure and stability affect parental resources, investments, and child well-being?

The Fragile Families Study was designed to answer these questions. It is a longitudinal study of a birth cohort of 5,000 children and their parents from 1998 to 2000. The participants were drawn from 75 hospitals in 20 cities with large oversample of non-marital births. Because almost all fathers come to the hospital to see the baby, the child's parents were both interviewed within 24 hours of birth. This ensured a high rate of response from the children's fathers (95%). Follow-up interviews are performed when children were 1, 3, 5 and 9 years old. Supplemental data is collected by way of in-depth interviews, medical records, and city/state characteristics and policies. DNA samples were collected at age 9. In the 15 year survey, DNA samples from mothers and children will be added to the Fragile Families data in order to do methylation studies.

The Fragile Families data has been studied extensively and continues to offer insights into how family structure influences children. Results include:

- About 51% of unmarried couples were cohabiting, 32% were visiting, 8% were friends, 9% have little or no contact. There are high rates of instability and new parental partnerships even by age 5.
- Children born to married parents are more likely to live in two parent households at age 5.
- Children born to unmarried parents are much more likely to have siblings from parents' other partners.

- Fathers who were not married at the child's birth are more likely to become incarcerated and report depression.
- Co-parenting appears to be important in terms of father involvement, and relationship quality appears to be important to the parental engagement of the father and mother.
- There are higher rates of obesity and aggression in children born to cohabitating or single parents.
- There may be gene by environment interactions for boys. Results suggest that more reactive alleles in the dopamine system correspond to higher rates of aggression when father enters or exits.
- Research on child-care regulations suggests that regulations may affect the quality of non-profit care but not for-profit care.

E. "Experiential, Genetic, and Epigenetic Effects on Human Neurocognitive Development," Eric Pakulak (University of Oregon)

More than three decades of the study of human brain development, using behavioral, electrophysiological and fMRI approaches have found that different brain systems and related abilities display different degrees and time periods of neuroplasticity. Some of these systems, such as central vision and central hearing, are more constrained. Other systems, like attention and languages, are modifiable and dependent on experience during particular time periods. Although human brain development is partly determined by genes, it is also determined by environment and gene by environment interactions. Consequently, it is possible for Early Childhood Interventions to both enhance and protect human brain development. Here, we focus on the development of attention.

There are different types of attention, but here we focus on sustained and endogenous selective attention. One way we study this is a technique called event-related potentials (ERPs), which is ideal for studies with children because brain activity is measured by "eavesdropping" on the naturally occurring electrcial activity at the scalp with an electrode cap . Studies of differences between deaf people and hearing people provided a starting point for the study of the neuroplasticity of attention. These studies have shown that neuroplasticity is a "double-edged sword" because it can confer the possibility for a system to be enhanceable or vulnerable. Early processes of selective attention (a larger brain response at 100 milliseconds to attended stimuli) are enhanced in adults who were born deaf or blind. Importantly, this enhancement of processing at 100 milliseconds is only found in adults who were born deaf or blind but not when blindness occurred later in development, suggesting that differential experience early in development is crucial. Evidence that these processes are vulnerable comes from studies of children from different socioeconomic status (SES) backgrounds. Children from lower SES backgrounds do not show this early effect (a larger brain response at 100 milliseconds to attended stimuli), while their peers from higher SES backgrounds do, and this deficit is specific to processes important for the suppression of distracting information.

Based on this basic research on neuroplasticity, an intervention targeting the vulnerable but enhanceable attention system was developed. This intervention, called Parents and Children Making Connections – Highlighting Attention (PCMC-A), includes both a parent training component and a child training component, with an emphasis on the parenting component. The parent compnent emphasizes positive reinforcement, specific praise, high quality language, and consistent discipline with clear expectations and natural consequences. The child component teaches children about the brain, how the brain controls the body, how it feels when attention wanes, how to continue paying attention, and includes activities to teach internal and external awareness. The parent component also includes instruction for parents on attention and home-practice activities they can use with their children.

The lab partnered with local Head Start and conducted a randomized control study with children ages 3-5 living at or below the poverty level and their parents. Participating families were randomly assigned to either

PCMC-A or one of two comparison groups: a passive comparison group in which children participated in Head Start as usual, and an active comparison group featuring an intervention with the same components but with more of an emphasis on the child component.

The results show that parents in PCMC-A report reduced stress and decreased problem behaviors and better social skills in their children. Their children show larger increases in language and non-verbal intelligence, and their children begin to show attention patterns more similar to those of their higher SES peers.

There is still much research that needs to be done on the development of attention and its malleability. Future assessments such as objective biomarkers of stress, executive function, parent language behavior, and changes in parents' behavior are essential to understanding how the intervention is working. Ongoing additional assessment using the ERP language paradigm can show results of the training programs for subsystems of language, and MRI results will also provide additional information on the effects of the training program on brain structure. The children are being followed longitudinally, and preliminary results suggest that the gains appear to be holding up over time. PCMC-A should also be tested with a broader demographic. In a follow-up project currently underway, PCMC-A is being adapted and translated into Spanish to serve Latino families, who are a fast-growing and at-risk demographic. Additional information can be found at the website http://bdl.uoregon.edu/, and a free video program for nonscientists about the effects of experience on human brain development can be found at: www.changingbrains.org.

F. "Epigenetic Consequences of Early Social Experiences in Rhesus Monkeys," Stephen Suomi (NICHD)

Because bonds between baby Rhesus monkeys and caregivers are similar to bonds between human babies and adults, studies of the long-term effects of early social experiences of Rhesus monkeys may shed some light on the long-term effects of similar early social experiences of human children. These particular studies look at the evolution differences between monkeys raised by humans and their peers (henceforth referred to as peer-reared) and mother-reared moneys over time.

Studies of peer-reared Rhesus monkeys have consistently shown worse outcomes for peer-reared monkeys. Human-reared monkeys become hyper-dependent on each other, develop less sophisticated play and have higher cortisol levels. They become more aggressive and have low levels of serotonin metabolism. When these monkeys are young adults and they can access sweet alcohol, non-alcoholic flavored beverages, or water, the peer-reared monkeys tend to consume alcohol. Additionally, the brains of peer-reared monkeys are different and they show less serotonin binding. They also show higher levels of infections, allergies and gastro-intestinal disorders. They tend to be wounded more often and have more accidents. There is an over-expression of genes involved in inflammation, cell differentiation and transcriptional control in peer-reared monkeys and under-expression of immunoglobulin production and Type 1 interferon antiviral response. These patterns may also be passed on to the next generation, insofar as mothers pass on rearing techniques.

These trends are beginning to be studied in terms of gene methylation. Many genes are differentially methylated depending on whether or not a monkey was peer-reared or mother-reared. Longitudinal methylation data show that the number of genes differentially methylated is about 5,000 at four months and 2,500 differentially methylated genes 2 years later. The number of differentially methylated genes is lower in females, with only 1,000 differentially methylated genes at two years. These results suggest that therapeutic environment has mediated the effects of peer-rearing versus mother-rearing. It also suggests a new critical period and a new set of genes, which are only observed in females at the onset of puberty.

Because there is strong evidence for long-term effects of rearing techniques, there has been a shift in focus toward understanding why these long-term differences arise. Early mother-infant interactions including mothers' protection of their babies, face-to-face interactions and imitation may be part of the mechanism driving the effects of peer-rearing versus mother-rearing. Like humans, newborn monkeys engage in substantial face-to-face contact with and imitate their mothers for a short period after birth. Differential expression of these behaviors is shown within a few days of birth for peer- and mother-reared monkeys. About 55% of rhesus monkey infants who are nursery-reared imitate by 3 days of age, while 95% of the mother-reared infants imitate by 3 days of age. Imitators play twice as much at 4-6 months of age, and show much higher levels of self-directed behavior such as thumb sucking and body clasping. To see the brain activity, electroencephalogram (EEG) marker documented imitation behaviors. Although the observable behaviors disappear quickly, these patterns persist in EEG measurements.