High-Quality Preschool Improves Academic Outcomes at Kindergarten:

A Regression Discontinuity Approach

Mariel Kyger, Ph.D., & Melissa Barnhart, Ph.D.

Los Angeles Universal Preschool (LAUP)

In 2004, Los Angeles Universal Preschool (LAUP)

was created as the result of a grant from First 5 LA

to establish access to high-quality preschool for children in Los Angeles County.

Why is it important to support high-quality preschool?

Research shows that children who attend preschool show improvements in literacy, mathematics, and social-emotional wellbeing.

(e.g., Slaby, Loucks, & Stelwagon, 2005; Barnett, Lamy, & Jung, 2005; Camilli, Vargas, Ryan, & Barnett, 2010; Yoshikawa et al., 2013)

LAUP believes that all children deserve the opportunity to benefit by participating in a high-quality early education program.

The benefits of preschool can last through high school, and even into adulthood. (e.g., Campbell et al., 2012; Schweinhart et al., 2005; Heckman, 2000)

For children from low-income or disadvantaged families, these benefits are even stronger. (Palfrey et al., 2005)

Affordable high-quality preschool narrows the educational gap between high- and low-income children, and helps to build a skilled and motivated adult population.
(Heckman, 2009)

Since LAUP's inception, studies have consistently demonstrated its benefits for preschool children.

LAUP students:

make significant progress in language and math from fall to spring, relative to peers nationally;

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LAUP students:

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meet established targets for cognitive and socio-emotional development;

exceed national averages on measures of attention, activity, and sociability;

earn standardized test scores equal to or better than high-income peers'.

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Quantifying the effects of quality

These findings are extremely encouraging!

However, they do not tell us how these same students would have performed <u>without</u> high-quality preschool.

To compare these effects to the effect of having no preschool,

we need to quantify the impact of LAUP on the population it serves.

One way to statistically quantify the impact of a program on its population is to calculate its effect size using a control group.

- Allows for causal statements

However, there are difficulties associated with identifying and testing control groups for preschool settings.

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2) Selection bias is likely, because children whose parents do not enroll them in preschool may be different from children whose parents do enroll them;

3) Impractical and unethical to randomly assign preschool children to a control group in which they would not receive early education.

Regression discontinuity avoids these issues by eliminating the need to treat one group while excluding another. In fact, it is

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Regression discontinuity methods have been used across many different fields, including economics, program evaluation, and political elections.

Researchers studying preschool have also begun to implement these methods.

(e.g., Barnett, Lamy, & Jung, 2005; Wong, Cook, Barnett, & Jung, 2007; Gormley, Gayer, Phillips, & Dawson, 2005)

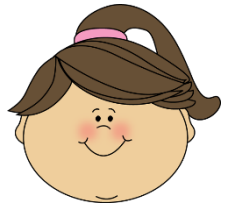
The basis of the regression discontinuity (RD) design:

Preschool admissions are often based on strict cutoffs.

If children must turn 4 before October 1st:

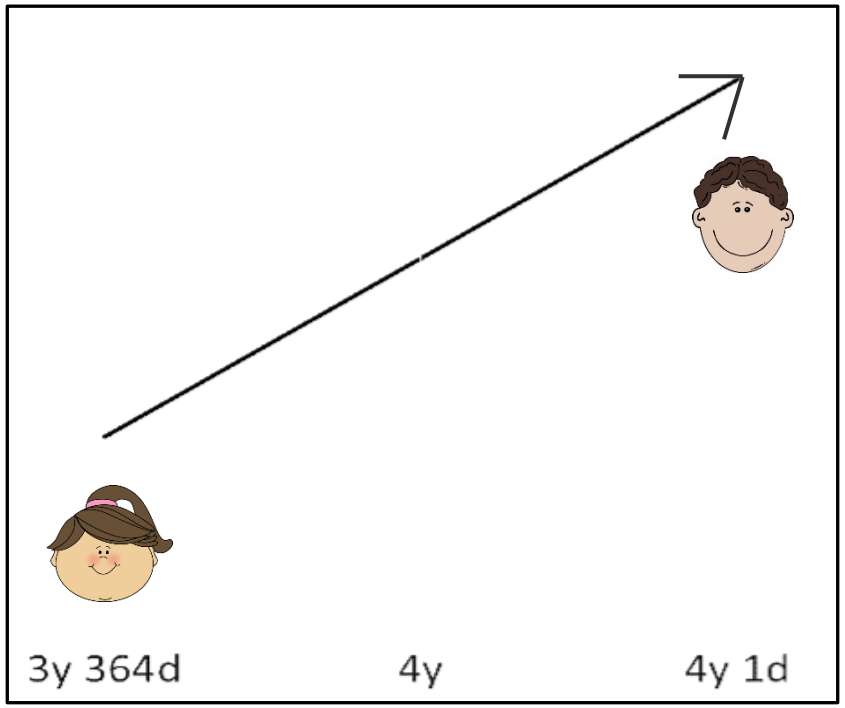
Children with birthdays on 9/28, 9/29, and 9/30 would be eligible for preschool in the current year.

Children born on 10/1, 10/2, and 10/3 would miss the cutoff for the current year, but would be eligible for preschool in the following year.



But: typical development is continuous!

A small, fairly consistent amount of development takes place on each day of a child's life. If we graphed this development, we would expect to see a straight line.



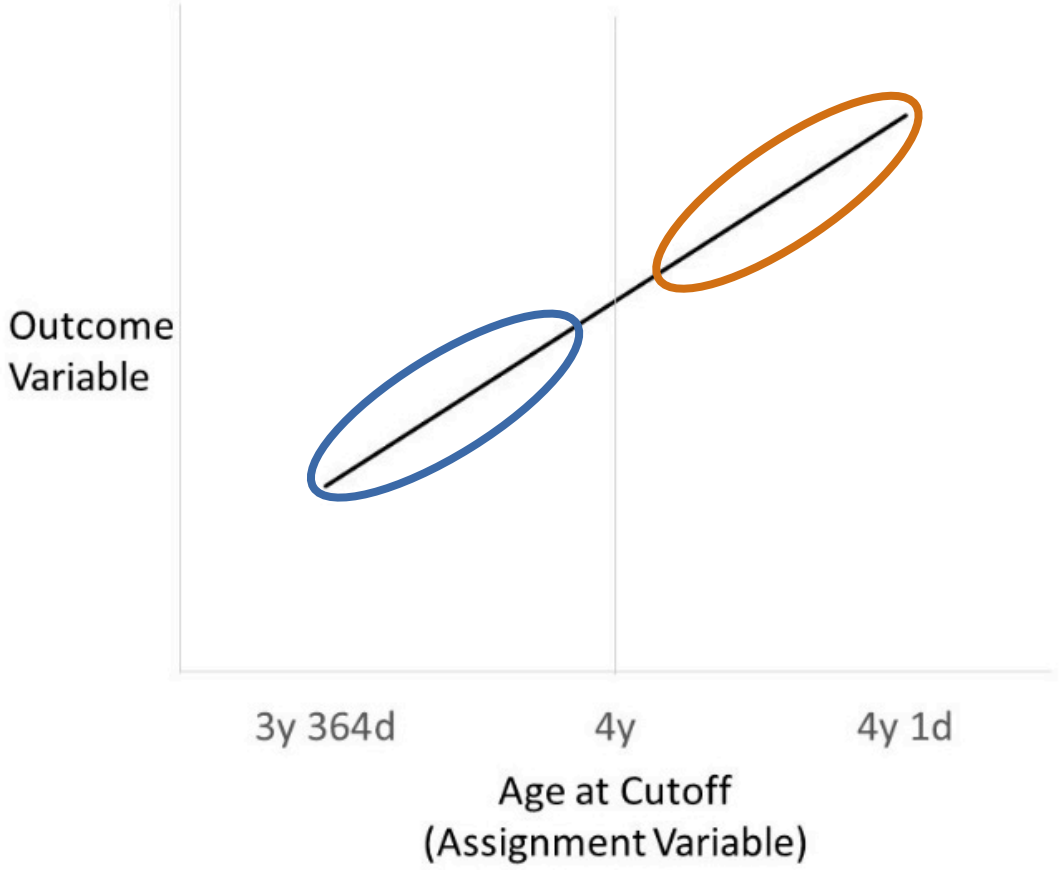
In other words…

if we compare learning outcomes for children born **on September 30**

to learning outcomes for children born **on October 2**,

and neither group attended preschool,

we would expect to see a continuous line between the two groups.



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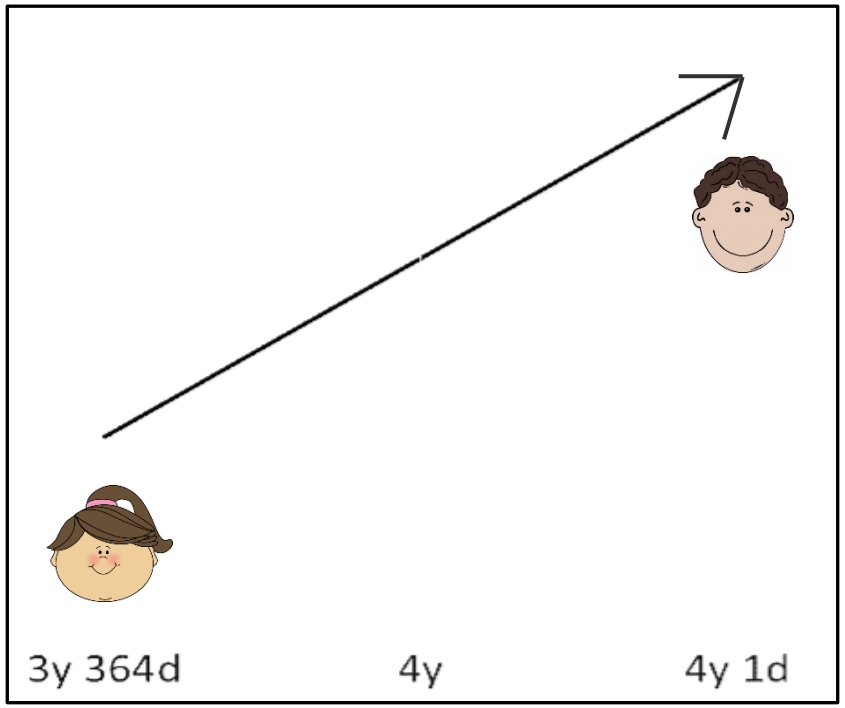


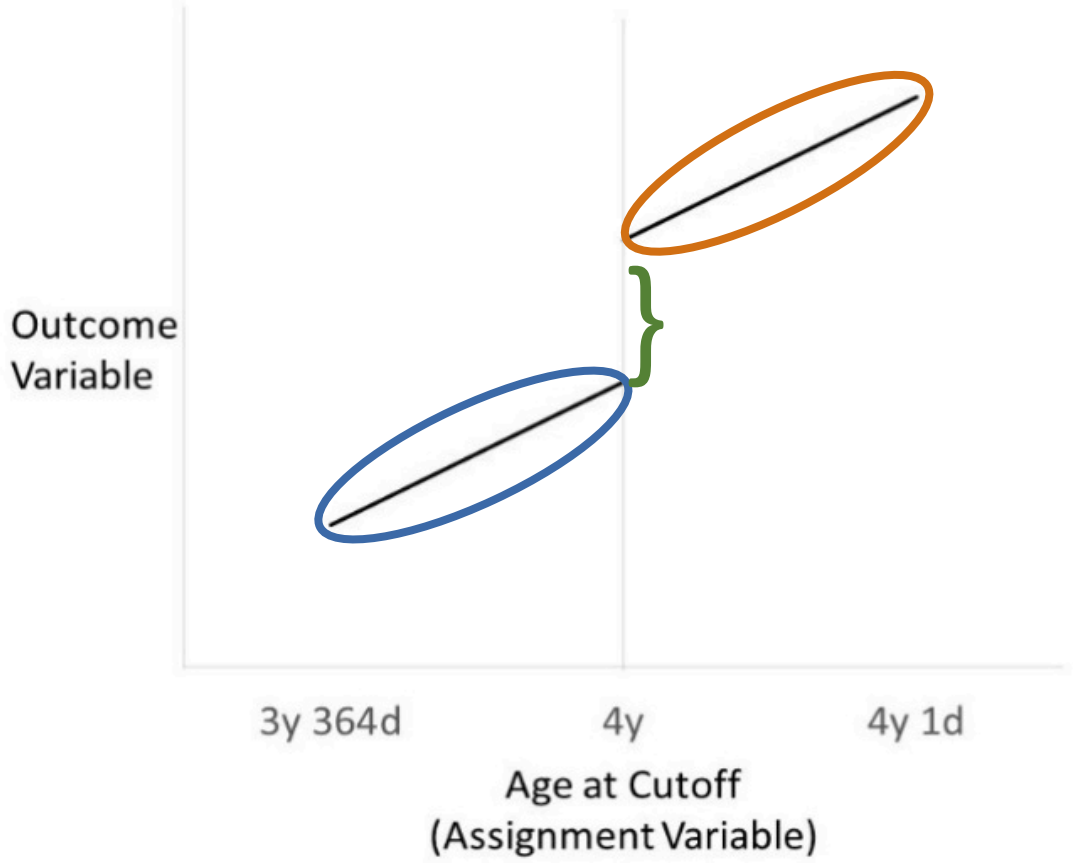
Using the principles of regression discontinuity,
we can take advantage of this continuous development
and the firm birthdate cutoff
to look for effects of preschool.

If we compare learning outcomes for children born **on September 30**

to learning outcomes for children born **on October 2**,

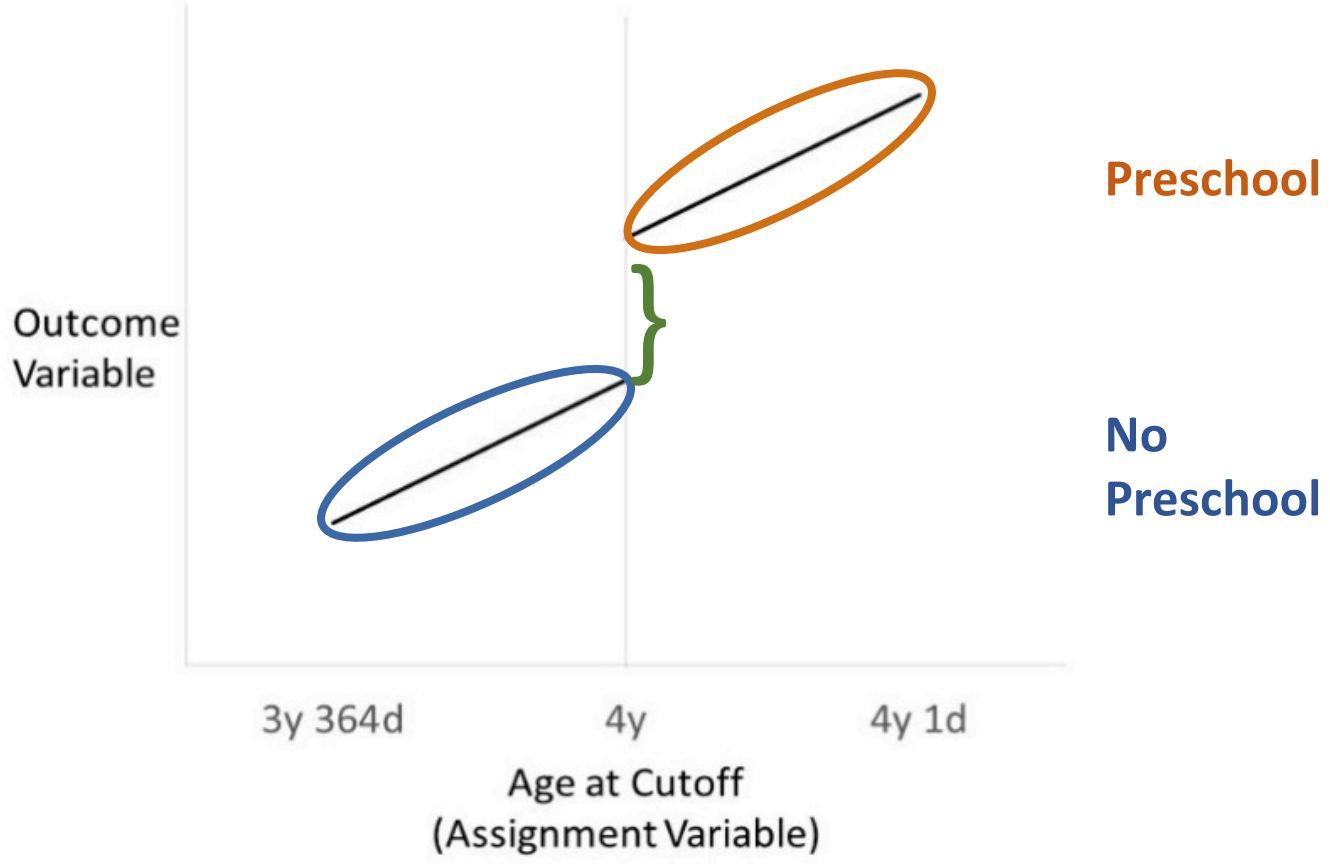
and only the slightly older group attended preschool,

we might see **a break, or discontinuity**, between the two groups.



This **discontinuity** between the two groups shows that one group experienced additional learning as a result of attending preschool.

The size of the "**jump**" between the two groups represents the preschool intervention's effect size.



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- Compared to control group designs, RD is more ethically acceptable
  because children with later birthdays will attend preschool in the coming year, instead of not receiving preschool at all.

- Differences aside from age will not confound or threaten results
  because they should be random (Barnett, Lamy, & Jung, 2005).

The only systematic variations are due to the effects of treatment – that is, we see systematic differences in ability due to preschool exposure.

Do children who have attended LAUP preschool for one year perform significantly better on measures of language and math ability, as compared to same-age children who have not attended LAUP preschool?

For ease of sampling, we pulled our sample from LAUP (Pre-K) and kindergarten (K) classrooms located at elementary schools.

To ensure that the cohorts were as comparable as possible, the Pre-K and K classrooms were selected from the same schools, within two large districts serving about 40% of all LAUP students.

We tested children within the first three weeks of the school year.

The “K” sample had experienced a full year of preschool

The “Pre-K” sample had experienced less than a month of preschool

Final sample = 18 classrooms

(9 K, 9 Pre-K)

Participants = 214 students

K: N=76 (41 female)

Pre-K: N=138 (63 female)

Materials and Testing

Language and mathematics

Frequently used measures (increased ability to directly compare our results).

Language: Dynamic Indicators of Basic Early Literacy Skills (DIBELS)

(Good & Kaminski, 2002)

Modules: Letter Naming Fluency, Phoneme Segmentation Fluency, Initial Sound Fluency.

Mathematics: Individual Growth & Development Indicators of Early Numeracy (IGDIs-EN)

(Hojnoski & Floyd, 2004)

Modules: Oral Counting, Number Naming, Quantity Comparison, One-To-One Correspondence Counting.

Easy, quick administration

5 mins each to complete; total testing time <10 mins per student (important!)

Assessment of students was one-on-one, either in a quiet corner of the classroom, or in a separate classroom.

Testing was scheduled to avoid naptimes and meal times.

Major benefit of regression discontinuity method:
No need to conduct follow-ups in the spring
or test the same children twice!

Data Analysis and RD Procedures

MDRC has published a paper called “A Practical Guide to Regression Discontinuity”, which guided our work.

Analysis steps taken:

Graphical presentation: Is there a jump at the age cut-off for preschool?

“If this graphical approach does not show evidence of a discontinuity, there is little chance of finding any statistically robust and significant treatment effects using more complicated statistical methods.” – Jacob, Zhu, Somers, & Bloom (2012)

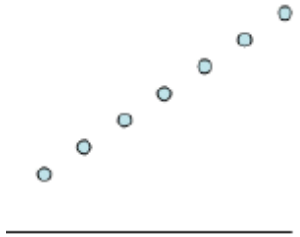
Treatment estimation: How large is the jump between the two cohorts of LAUP children?

One of the benefits of treatment estimation is that it provides a quantitative measure of the size of the jump, i.e., the effect of the program.

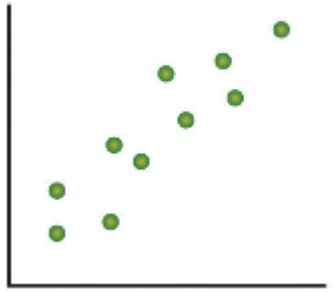
Step 1: Initial Graphical Depictions

Major goal is to determine the form of the relationship between children's age and the outcome variables.

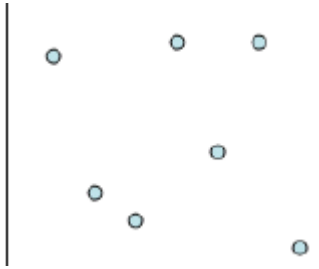
Is the relationship linear?



Is it curvilinear?

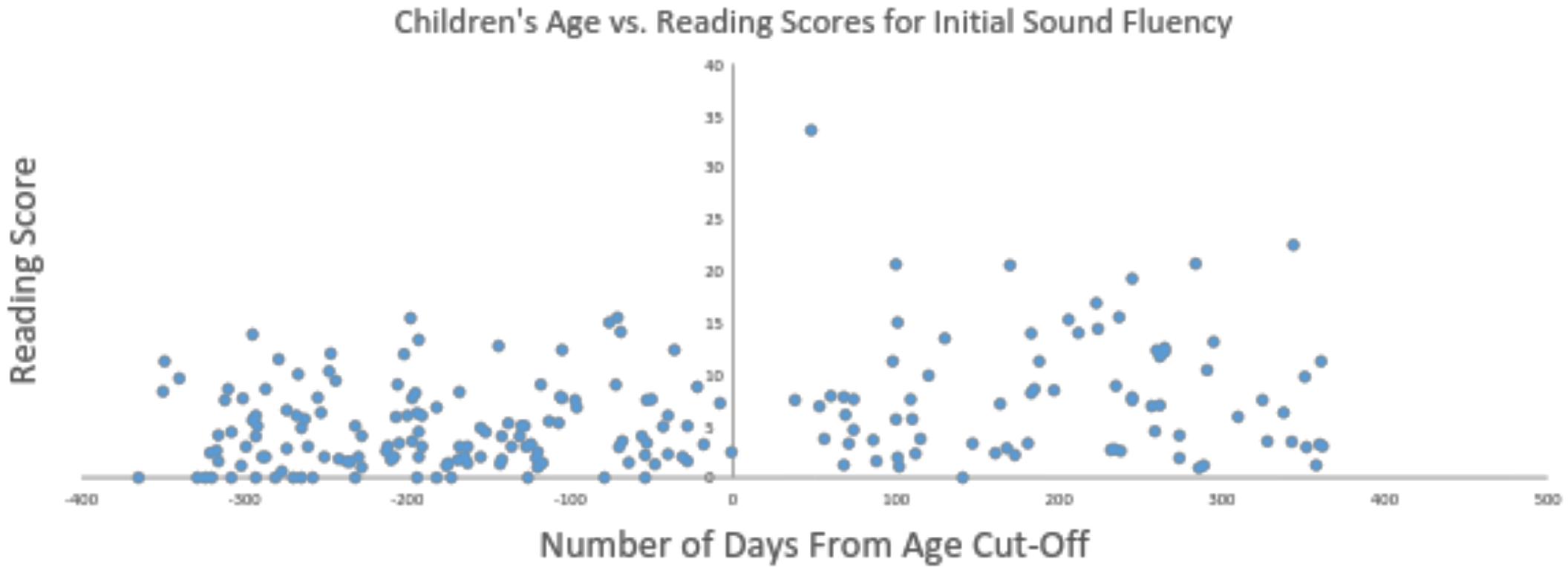


Is there a pattern at all?



Graphical Depiction – Example

What is the form of the relationship between age and reading scores in the following graph? Can you see the jump?



Grouping of Children Aids Graphical Depictions

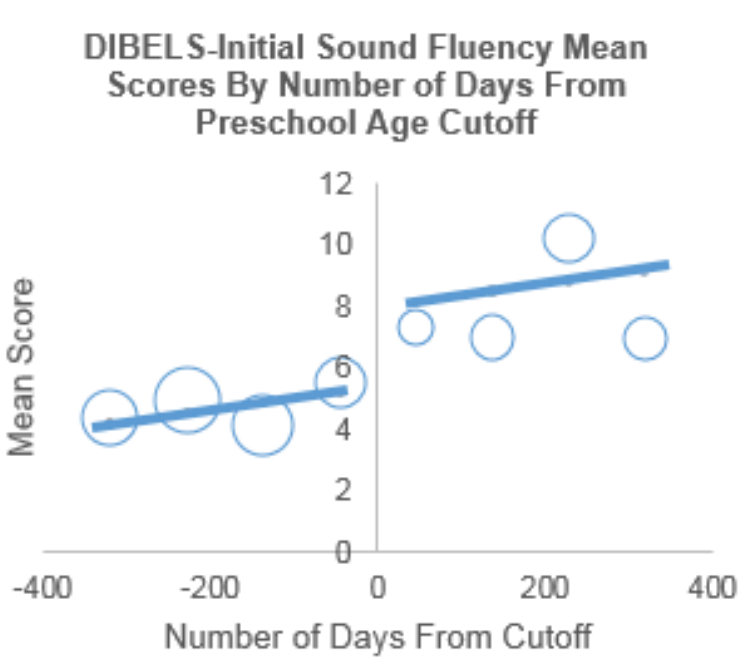
We grouped children of similar ages into “bins,” and graphed the average outcome score for each bin of children.

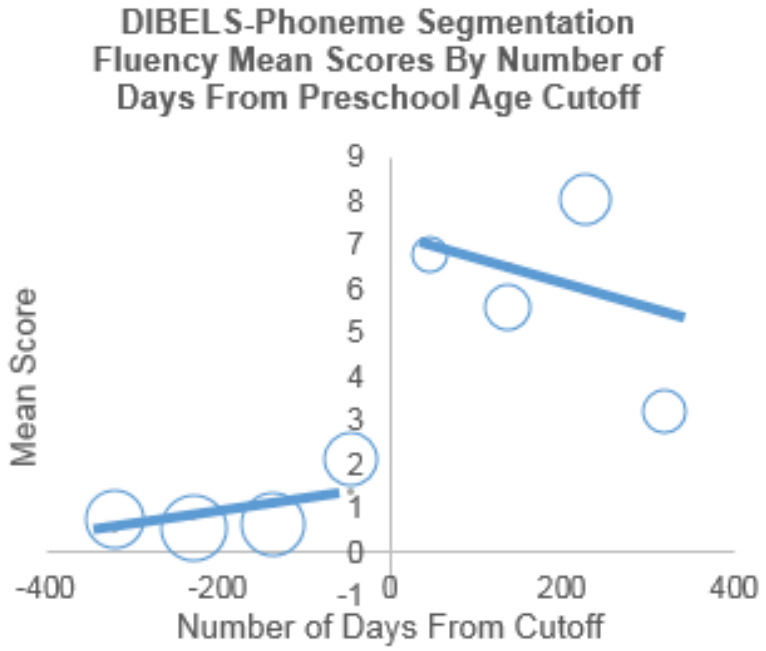
We grouped children into 4 bins on each side of the age cut-off (x-axis). Each bin contained children with birthdays within a 90-day period.

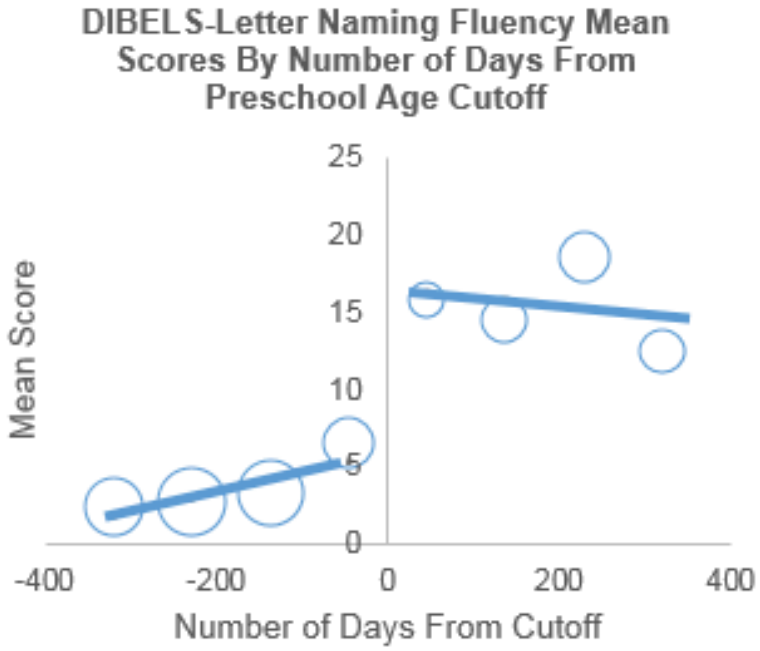
We calculated the average outcome score for the three reading scores and the four math scores (y-axis).

Bin	Days from Cutoff	N	%
1	(-365, -274)	32	15.0
2	(-273, -183)	42	19.6
3	(-182, -92)	38	17.8
4	(-91, 0)	26	12.1
5	(0, 91)	13	6.1
6	(92, 182)	20	9.3
7	(183, 273)	24	11.2
8	(274, 365)	19	8.9

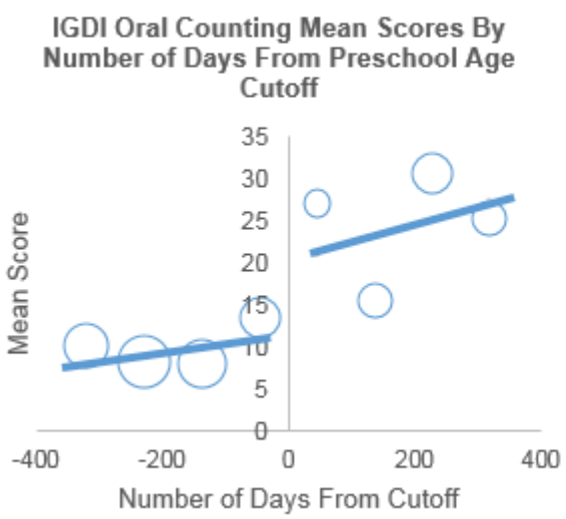
Reading Scores

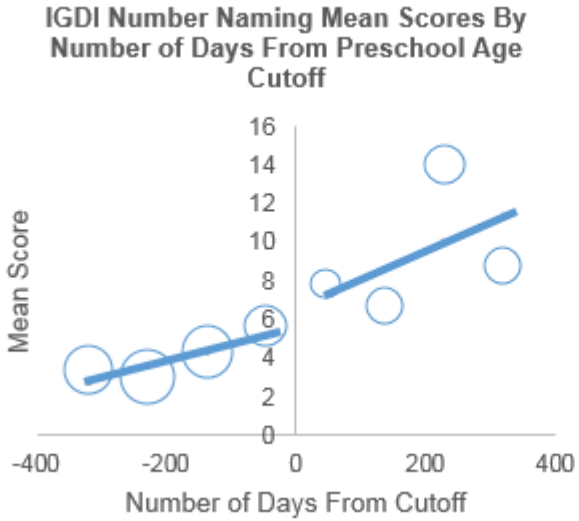


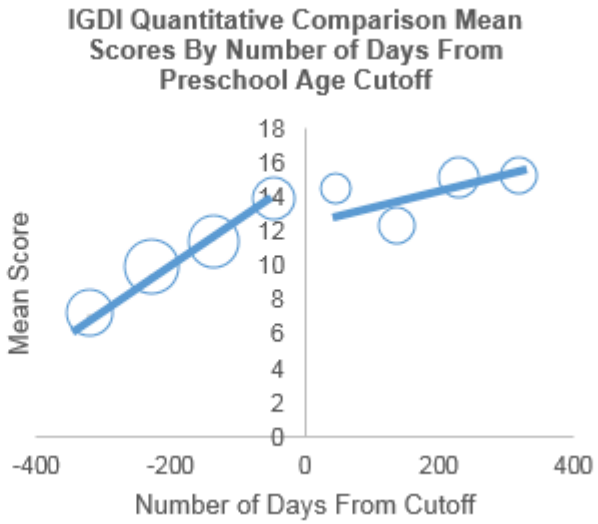


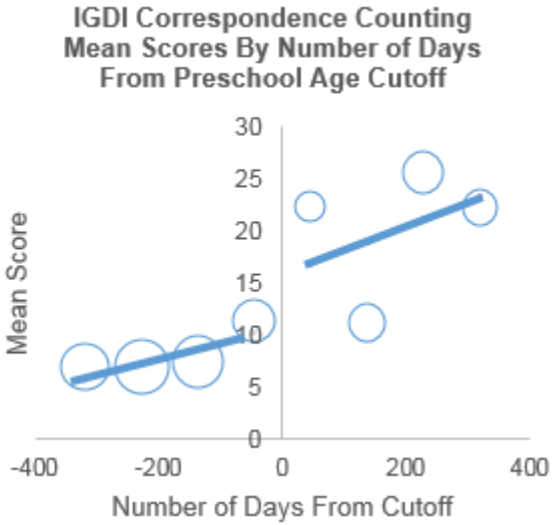


Math Scores


IGDI Oral Counting Mean Scores By Number of Days From Preschool Age Cutoff
Mean Score
35
30
25
20
15
10
5
0
-400
-200
0
200
400
Number of Days From Cutoff


IGDI Number Naming Mean Scores By Number of Days From Preschool Age Cutoff
Mean Score
16
14
12
10
8
6
4
2
0
-400
-200
0
200
400
Number of Days From Cutoff


IGDI Quantitative Comparison Mean Scores By Number of Days From Preschool Age Cutoff
Mean Score
18
16
14
12
10
8
6
4
2
0
-400
-200
0
200
400
Number of Days From Cutoff


IGDI Correspondence Counting Mean Scores By Number of Days From Preschool Age Cutoff
Mean Score
30
25
20
15
10
5
0
-400
-200
0
200
400
Number of Days From Cutoff

Step 2: Estimation of Treatment Effects

After determining that most of our outcomes had a **linear** relationship with children's age, we used a linear regression that included an effect for the treatment.

We standardized the treatment effects to produce the effect sizes for each outcome.

Effects of LAUP Preschool

Predictor	DIBELS-Initial Sound Fluency		DIBELS- Letter Naming Fluency			DIBELS-Phoneme Segment. Fluency			IGDI- Quant. Comparison	
	B	*(SE)*	*B*	*(SE)*		*B*	*(SE)*		*B*	*(SE)*
Intercept	4.71	3.87	10.35	2.20	**	2.14	1.19		14.09	1.38
Participation in LAUP preschool (treatment)	2.66	4.58	9.71	3.00	**	6.09	2.01	**	-2.75	1.80
Time from cutoff (days)	0.00	0.01	0.01	0.01		0.00	0.00		0.02	0.00
Female	-0.14	1.89	0.10	1.23		-0.95	0.66		-1.27	0.79
Minority (African American or Latino)	1.01	2.80	-4.88	1.89	**	-0.28	1.38		2.03	1.18
Low household income (<$25,000)	0.42	2.67	-3.57	1.52	**	-0.08	0.90		-0.04	1.03
Father education-not a high school graduate	0.74	3.24	0.34	2.01		-0.39	1.08		-0.52	1.48
Mother education-not a high school graduate	-1.19	3.85	0.26	2.20		-0.22	1.09		0.85	1.50
Non-English primary home language	-1.15	2.46	-0.42	1.49		-1.49	1.01		-2.88	1.10
R^2	0.12		0.39			0.21			0.25	
Effect size	0.43		0.83			0.76			-0.50	

* p<.05; ** p<.01

We found significant benefits for LAUP students
in the areas of Phoneme Segmentation and Letter Naming.

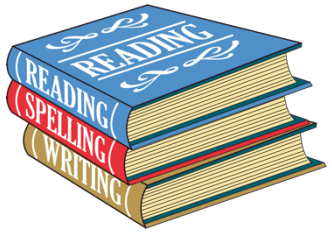
Both of these modules test important pre-literacy skills.

The ability to recognize letters and phonemes within a word becomes crucial as children learn to read printed materials.

These skills reliably predict later reading comprehension and decoding skills.

(e.g., Strickland & Shanahan, 2004)

Many of LAUP's students are ELL or DLL (primarily English/Spanish), making these language effects especially encouraging.



Despite these large effect sizes in language,
we did not find significant differences in the math modules.

Why might this be?

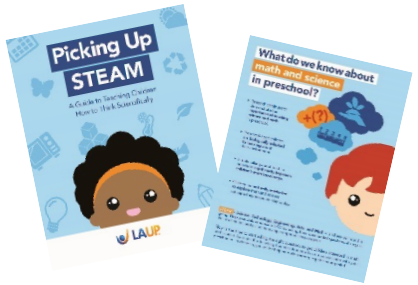
Teachers may spend extra time on English (versus math) to support K readiness in DLL students

Research also suggests that preschool teachers feel less confident in teaching math (e.g. Clements & Sarama, 2011; Ryan, Whitebook, & Cassidy, 2014)

This could be addressed with enhanced professional development.

STEAM module for yearly teacher trainings

Site-based STEAM practice and teacher toolkits



This design allows us to state that LAUP participation led to significant improvements in language, reflected by large effect sizes.

Benefits of calculating early education effects:

To the ECE field in general:

- Legitimizes the profession
- Provides advocates with research to cite
- Can answer remaining questions from previous studies

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On an individual basis:

- Can provide evidence of the effectiveness of a given program
- Supports fundraising and grant-writing efforts by organizations

So you want to conduct an RD study…

Recruit and consent participants early.

Get IRB and school permissions before the year starts! Especially true for large districts.

Communicate with all gatekeepers (supervisors, principals) often.

If you obtain parent consent in spring of Pre-K year, expect attrition by fall of K year.

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Statistical resources we found helpful:

Bartik, 2013 – *Effects of the Pre-K Program of Kalamazoo County Ready 4s on Kindergarten Entry Test Scores*

Jacob, Zhu, Somers, & Bloom, 2012 – *A Practical Guide to Regression Discontinuity*

Thanks to everyone who made this project possible!

Data Collection:

- Drew Barrett
- Adrienne Coppola
- Makaela O'Connell
- Joe Martinez

General Support:

- Rosa Valdes

A big thanks to the principals, teachers, and parents who facilitated our work…

And to the four- and five-year-olds who participated!

For more information about LAUP's research, advocacy, and quality support services, visit us at:

www.laup.net