

# Impacts of BPS K1 on Children's Early Numeracy, Language, Literacy, Executive Functioning, and Emotional Development

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# Summary of results

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- Largest mathematics and receptive vocabulary impacts to date in a public preK evaluation
- Small effects on children's executive functioning and emotional development
- All students are benefitting from K1; some effects stronger for Latino, ELL, and free/reduced lunch eligible children



# Study Motivation: BPS

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- Significant investment of city resources in K1 and in K1 quality (curricula, coaches, training)
- Are these investments paying off in terms of better child development?
- Helps us understand how K1 is contributing to closing achievement gaps and promoting the success of all children
- Opportunity to get rich data on two cohorts of K1 students for use in studying longitudinal impacts of K1



# Research Questions

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- RQ1: What is the causal impact of the Boston Public Schools prekindergarten program on child early mathematics, language, literacy, executive functioning, and emotional development outcomes?
- RQ2: Do some student subgroups benefit more from the program than others?

# K1 basics

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- Pre-k: About 28-35% of city 4-year-olds enrolled; enrollment open to any 4-year-old in the city
- Teachers paid on same scale and subject to same educational requirements as K-12 teachers
- Uniform curricula - *OWL* (Schickedanz & Dickinson, 2007) and *Building Blocks* (Clements & Sarama, 2007)
- Early childhood coaching system – one set of coaches supporting two curricula



# Fidelity of Implementation

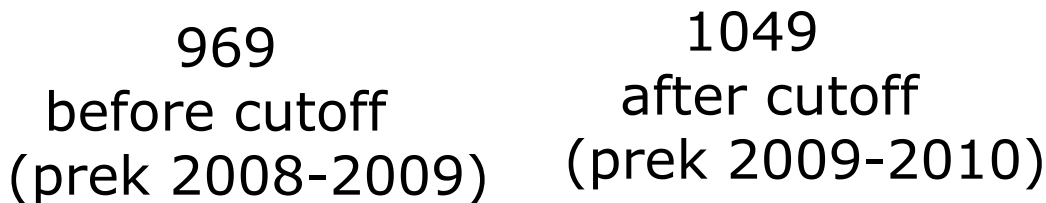
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- Observations conducted in 74 prekindergarten classrooms during treatment year
- Curricula were moderately to highly implemented

# Sample

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2,018 children  
(in 67 schools)



Race/ethnicity  
11% Asian, 27% Black,  
41% Hispanic, 3%  
Other, 18% White

Home language  
50% English, 27%  
Spanish, 22% Other

Gender, Free/reduced  
lunch, and Special needs  
51% male, 69% receive  
free/reduced lunch, 9%  
special needs

*Final sample represents 85% of schools  
& 70% of eligible children in those schools*

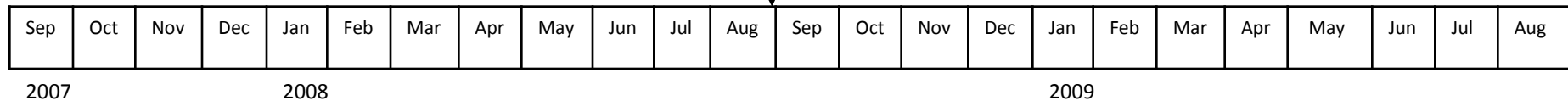
# Study design for child-level impacts: Regression discontinuity

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**SEPTEMBER 1  
BIRTHDAY CUTOFF**

**“Treatment” Group  
(attend prek in 2008-2009)**

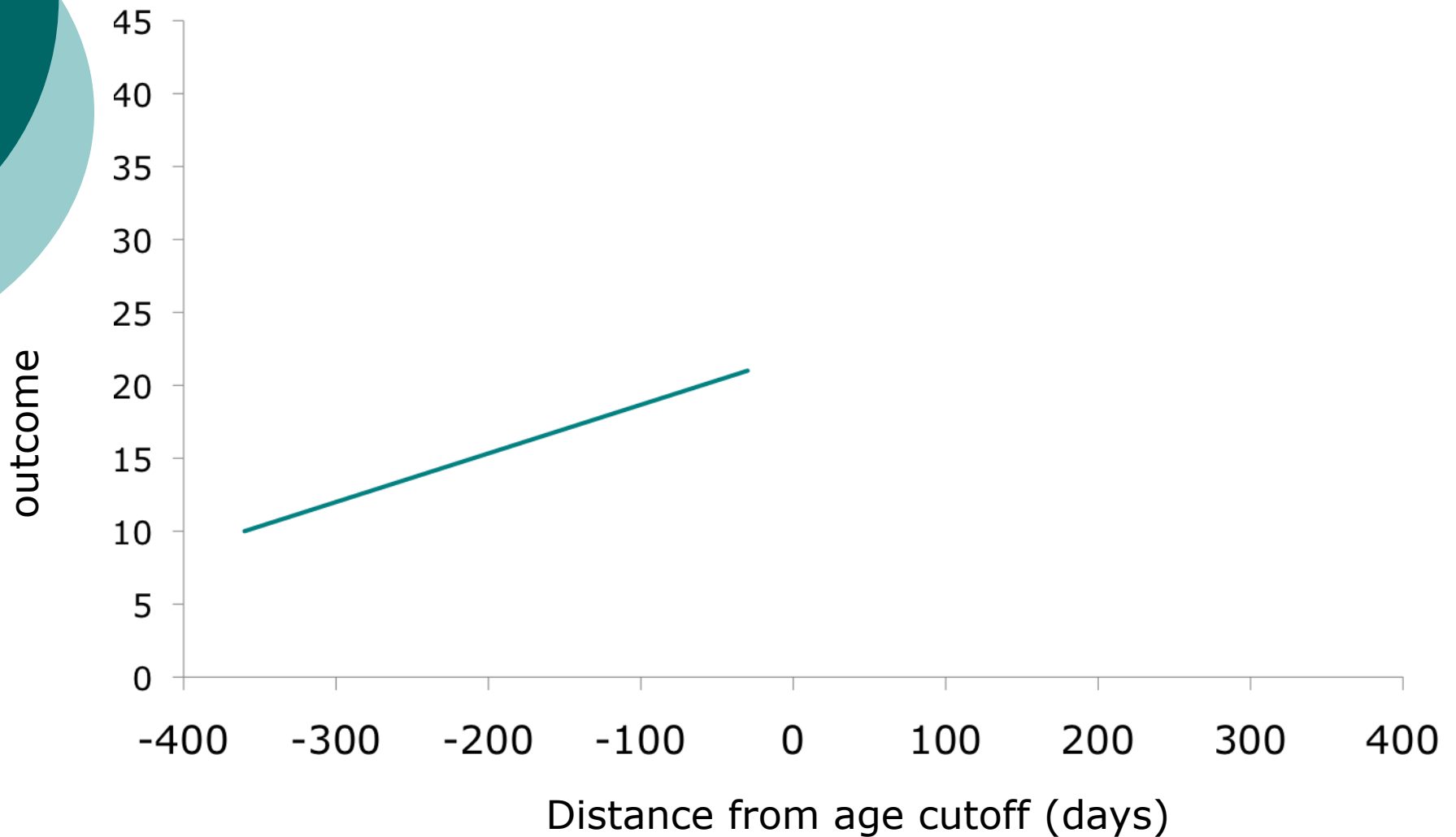
**“Control” Group  
(attend prek in 2009-2010)**





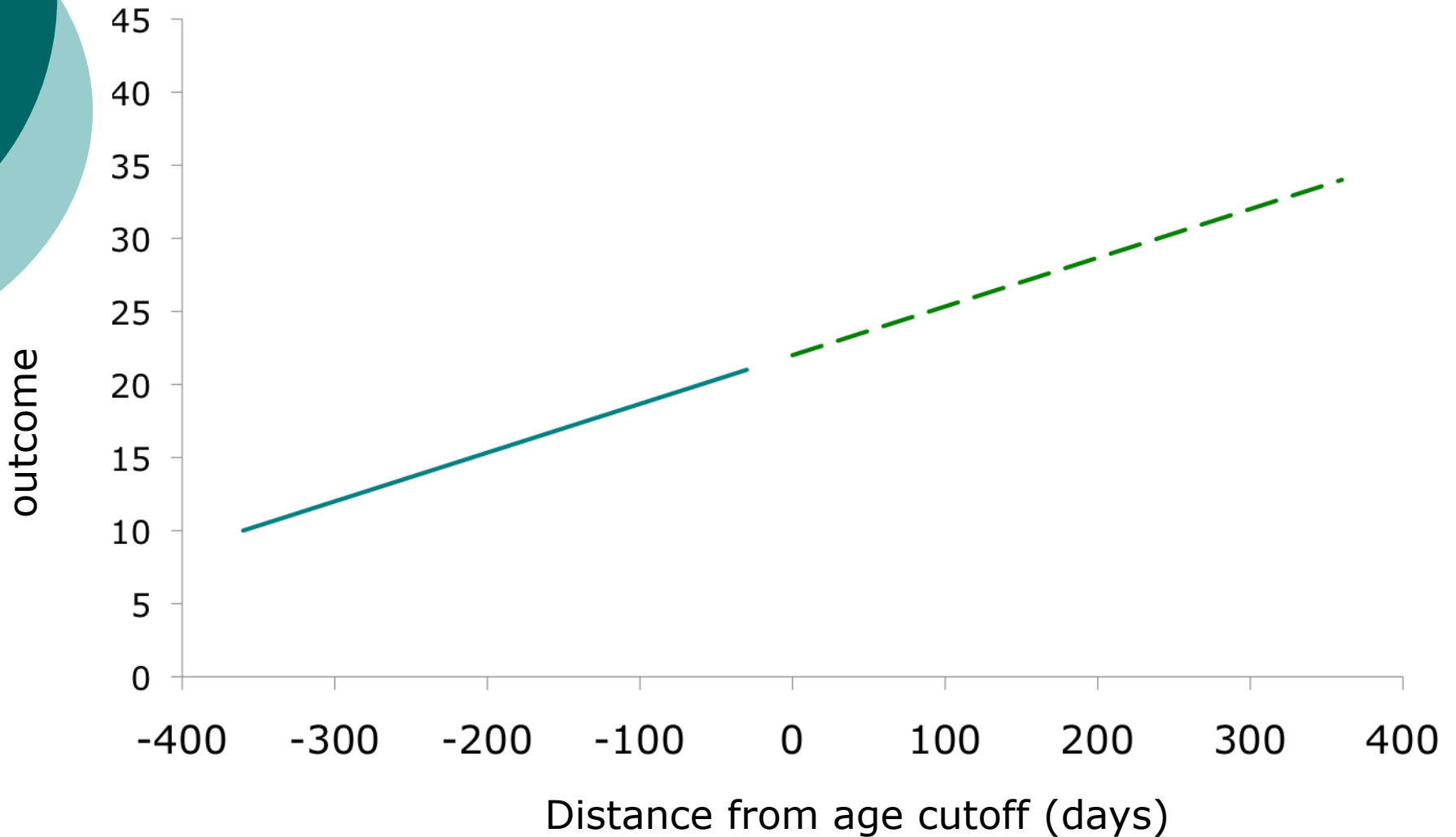
# RD illustration

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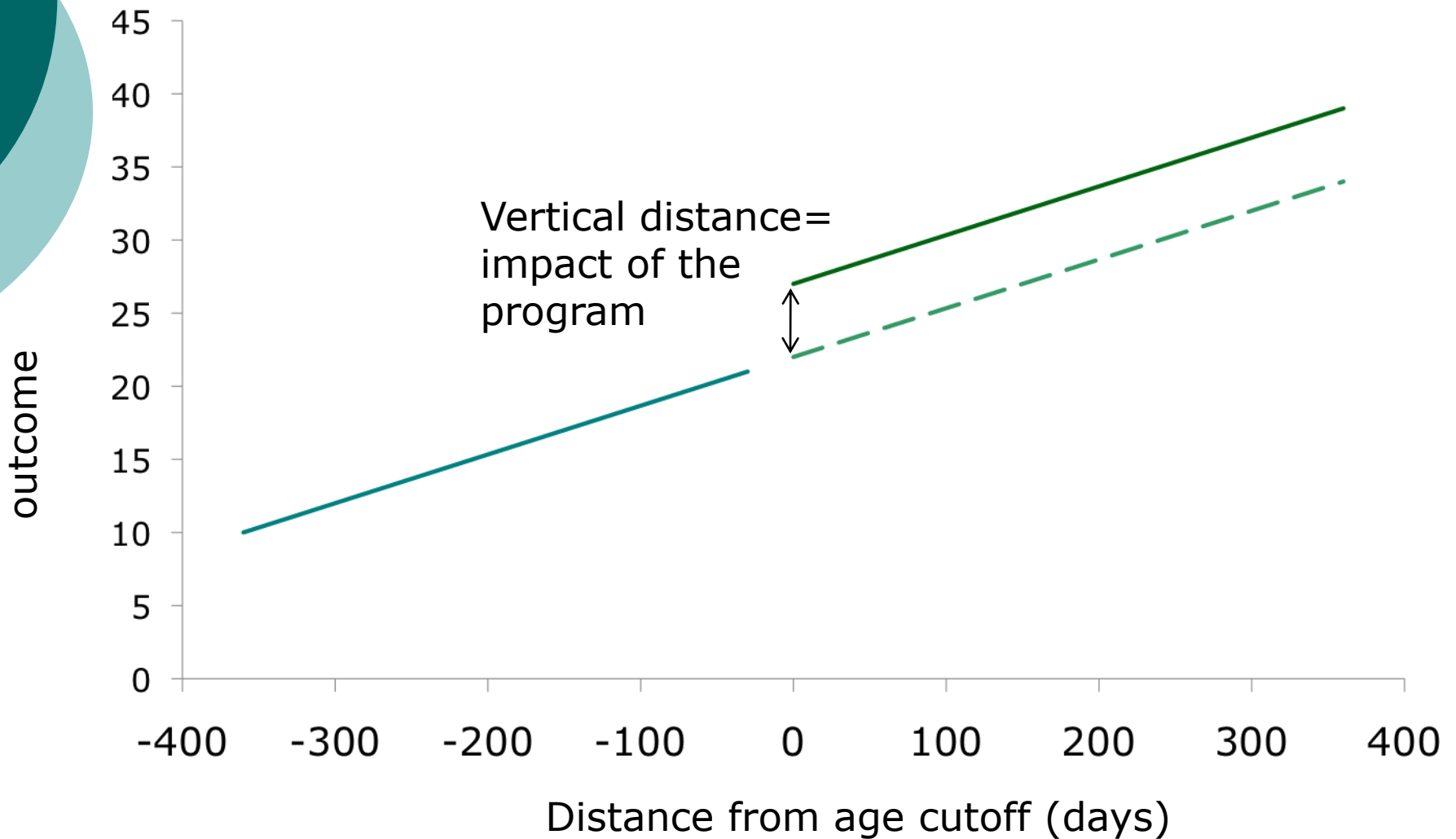


# RD illustration

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# RD illustration



# Can we trust our results?

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- Yes:
- Scrutinized by leading methodologists around the country.
- Results robust to host of sensitivity analyses.

# Outcome Measures: Math, Language and Literacy Skills

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- A trained assessor tested children one-on-one on a battery of tests, including:
  - Early math: *Woodcock-Johnson Applied Problems subscale* (Woodcock, McGrew & Mather, 2001) and *Research-based Early Math Assessment Short Form* (Weiland et. al, in press)
  - Language: *Peabody Picture Vocabulary Test-III* (Dunn & Dunn, 1997)
  - Literacy: *Woodcock-Johnson Letter-Word Identification subscale* (Woodcock, McGrew & Mather, 2001)

# Outcome Measures: Executive Function Skills

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- Executive Function:
  - Working memory: *Forward and Backward Digit Span* (Gathercole & Pickering, 2000; Wechsler, 1986 )
  - Inhibitory control: *Dimension Change Card Sort* (Frye, Zelazo & Palfai, 1995), *Pencil Tap* (Diamond & Taylor, 1996)
  - Attention shifting: *TOQ Attention* (Smith-Donald, et al., 2007)

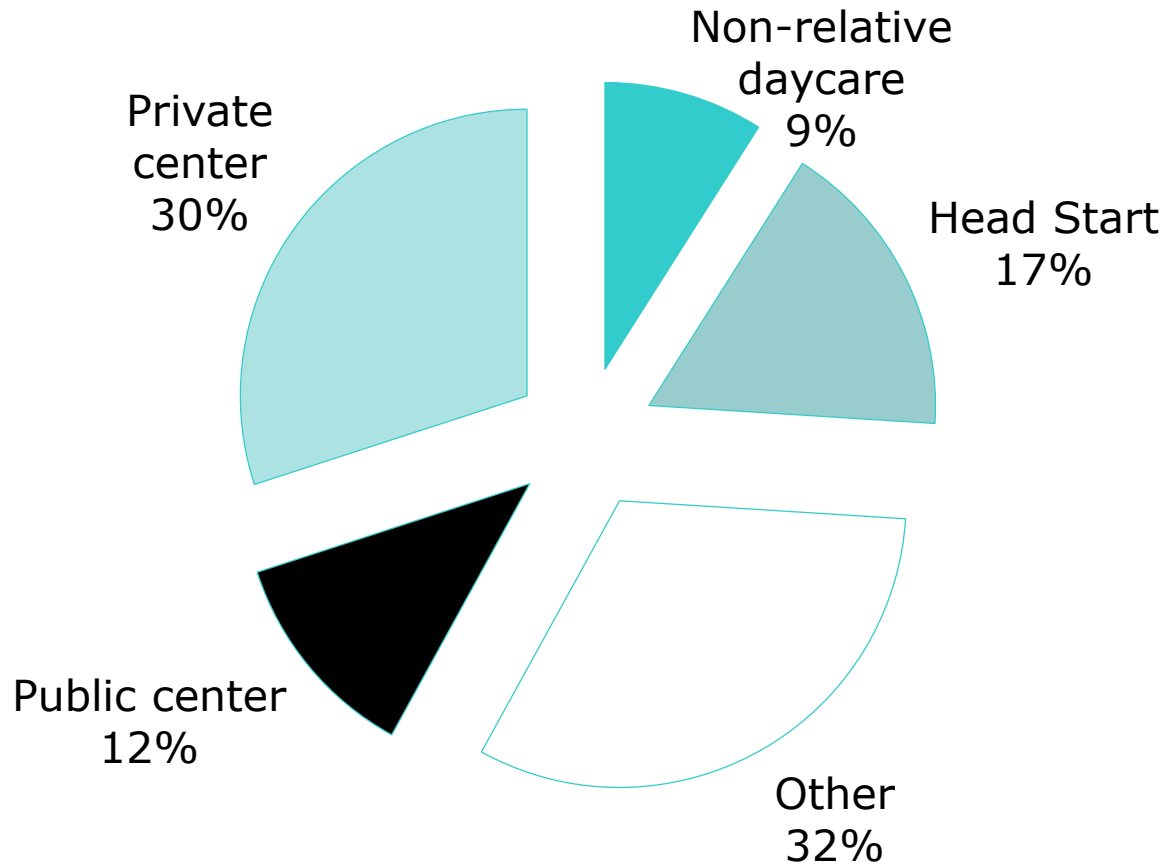
# Measures: Emotional Development

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- Emotional Development:
  - Emotion labeling: *Emotion Recognition Questionnaire* (Ribordy, Camras, Stafani, & Spacarelli, 1988)
  - Positive emotion: *TOQ Positive Emotion*, (Smith-Donald, et al., 2007)
  - Impulse control: *TOQ Impulse Control* (Smith-Donald, et al., 2007)

# Results: Care experiences of “control” group children in 2008-2009

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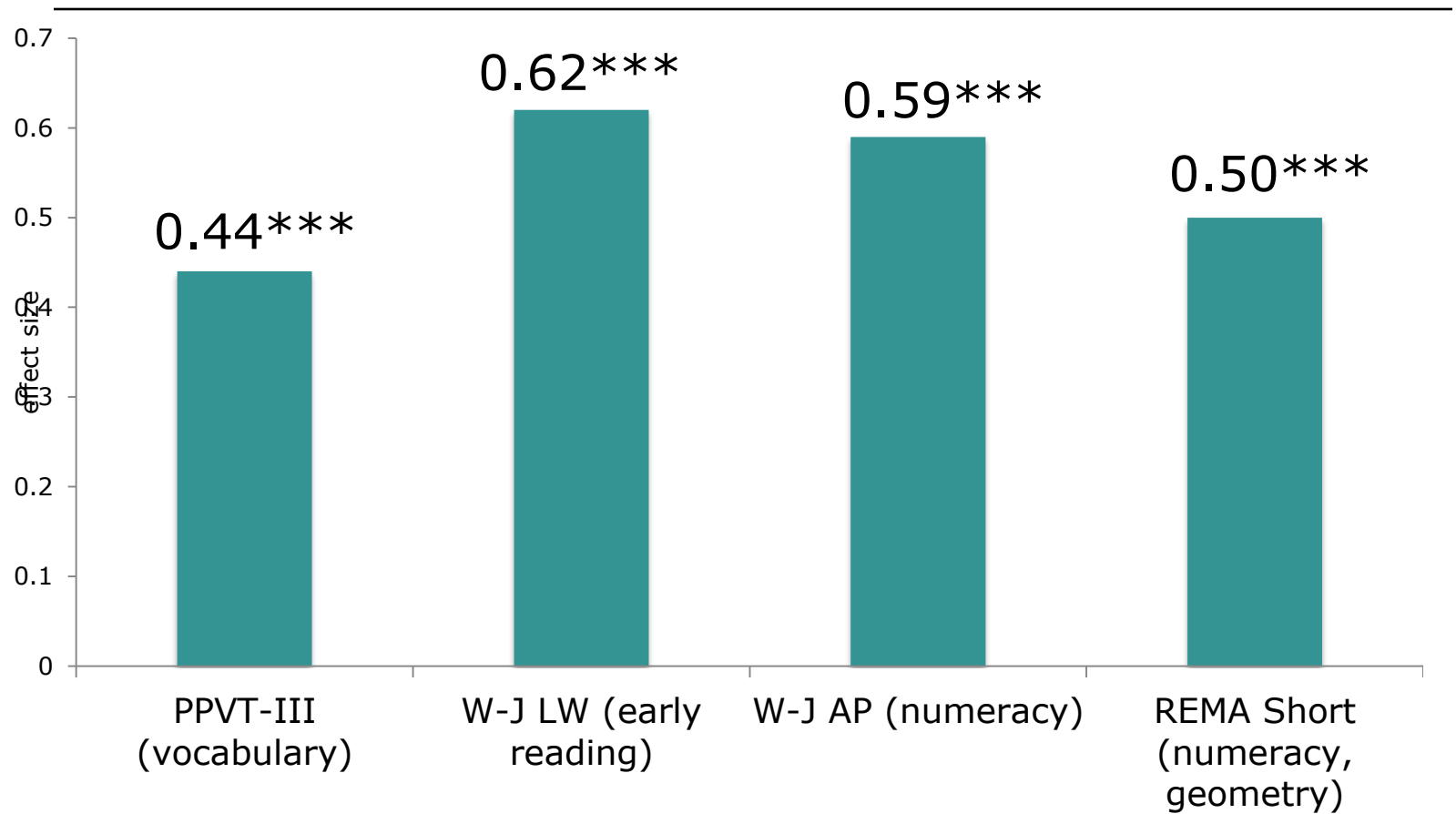


## Results: Format of child impacts

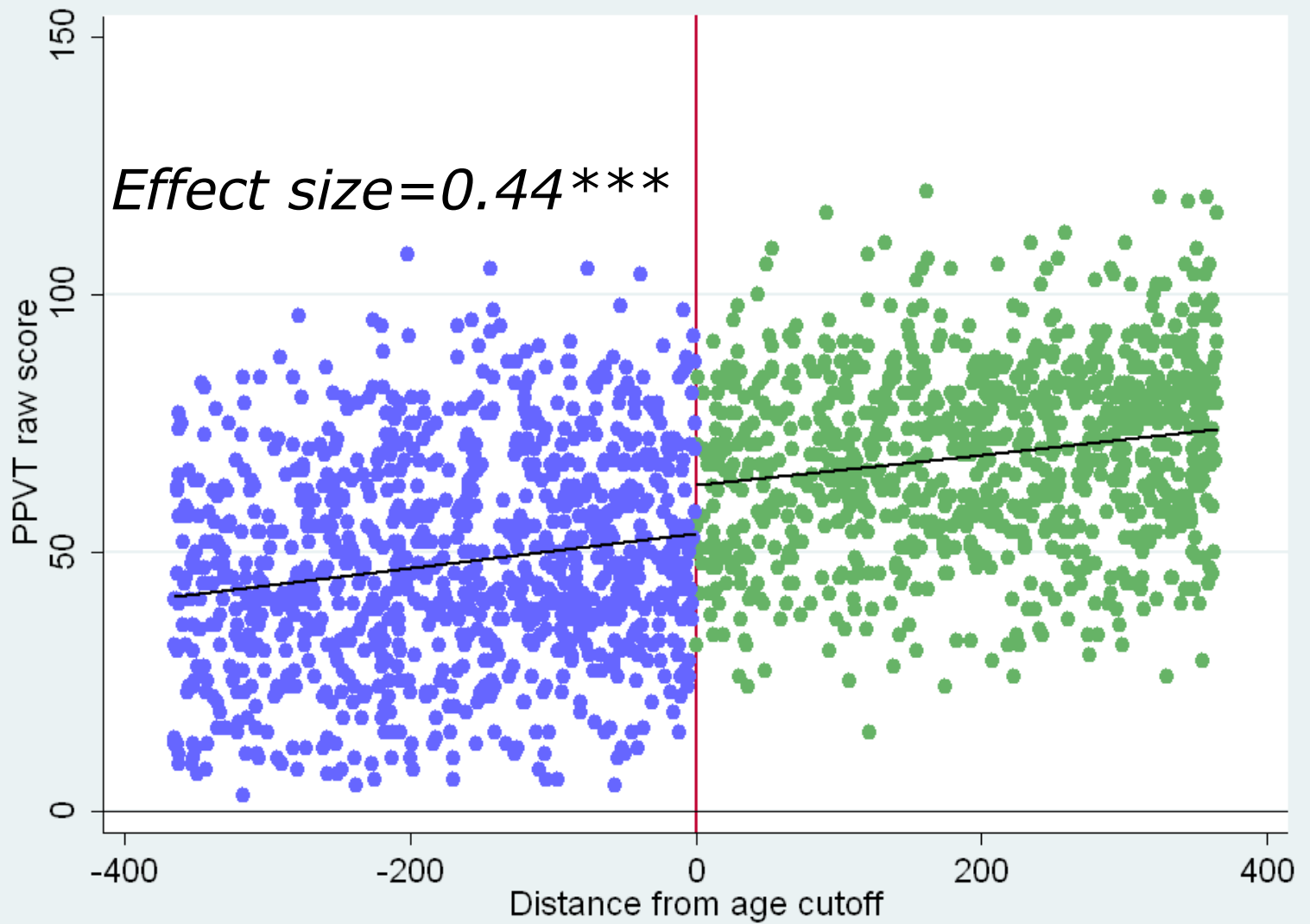
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- Translated into effect sizes – a standardized measure that allows to compare results across studies
- Typical effect size in an educational intervention is around 0.20
- Small effect:  $<0.30$
- Moderate effect: 0.40-0.60
- Larger effect:  $>0.60$

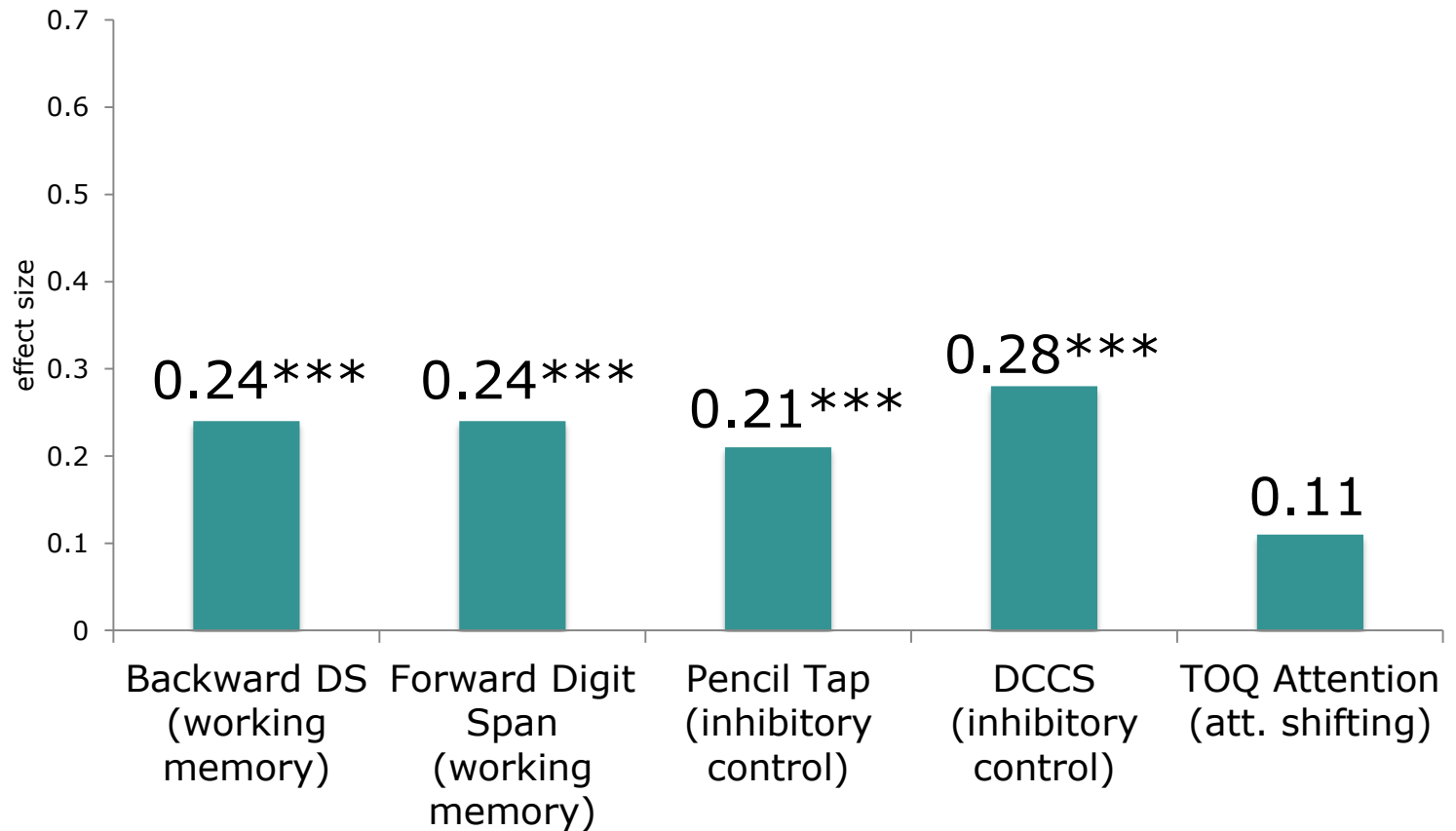
# Results: Language, Literacy, and Mathematics



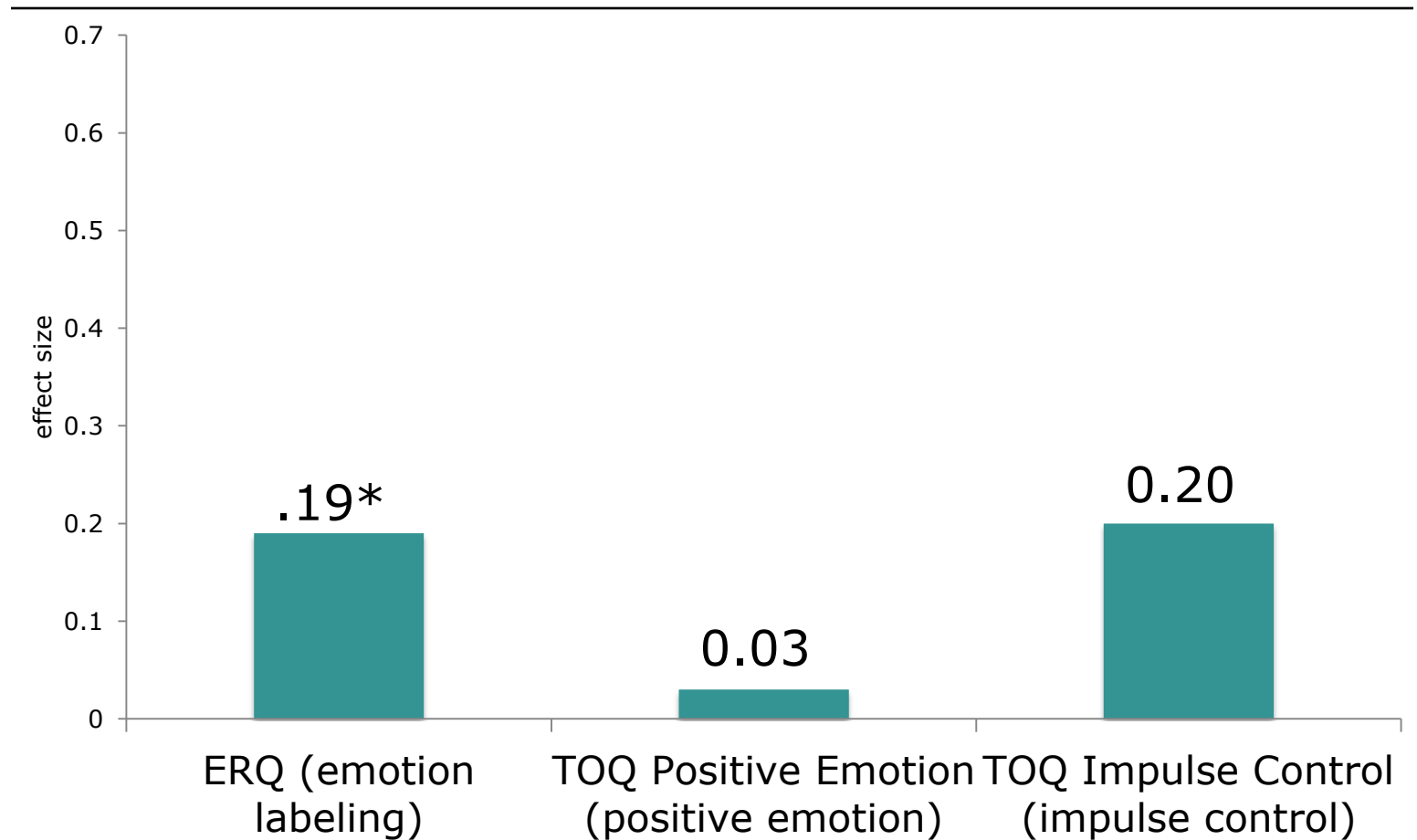
# Plot of the PPVT Effect



# Results: Executive Function



# Results: Emotional Development/Regulation



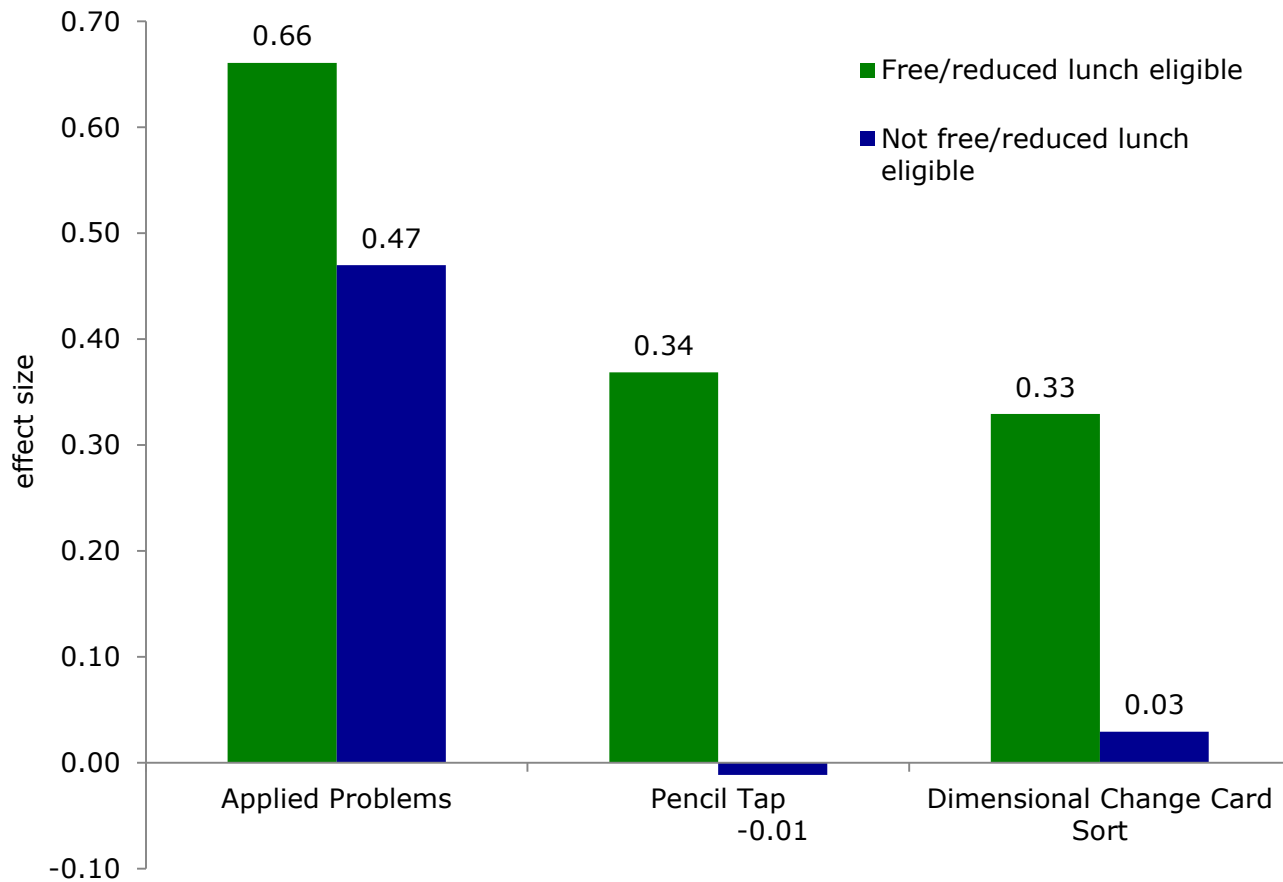


## RQ2: Subgroup effects

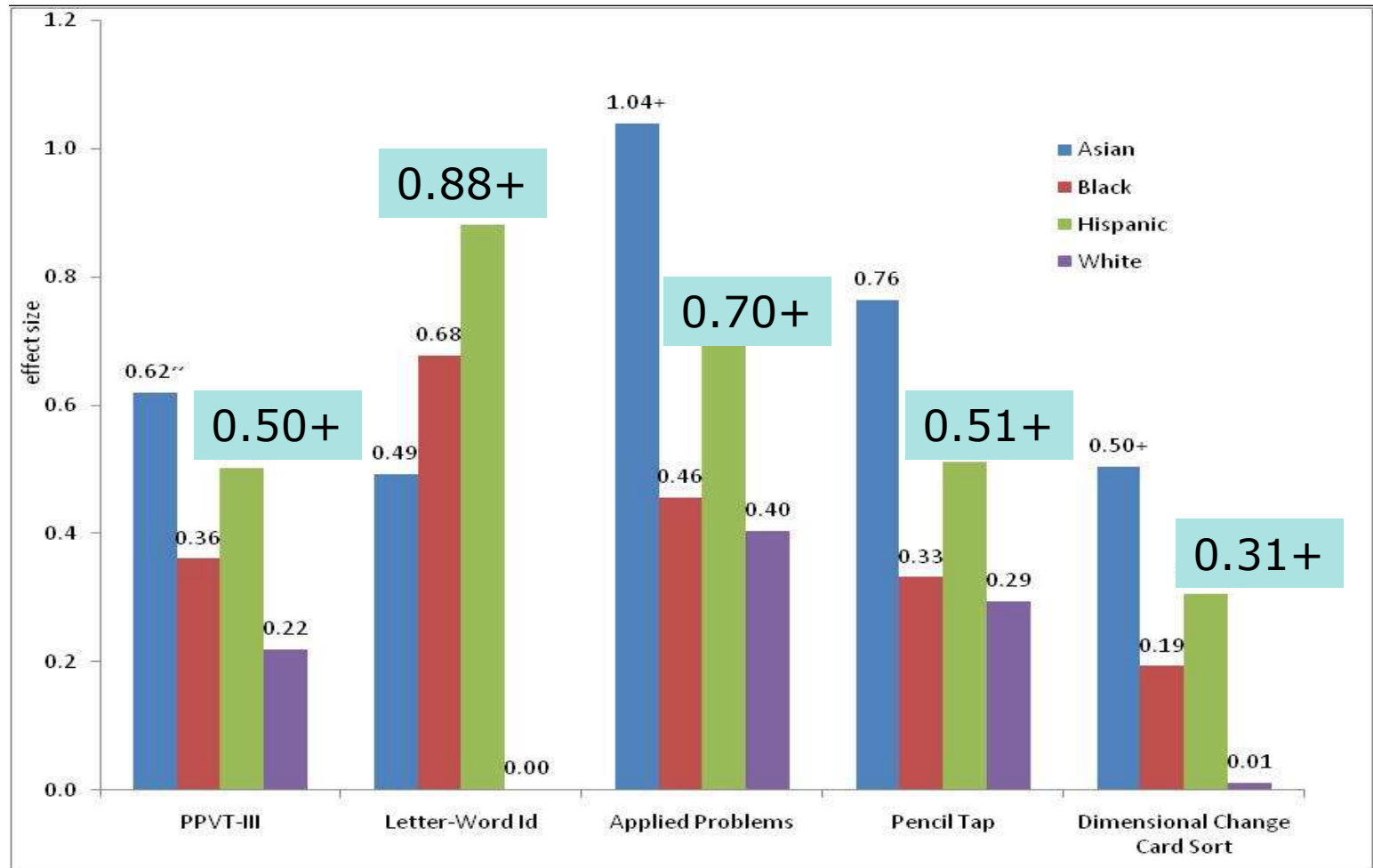
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- Subgroups of interest: Free/reduced lunch, race/ethnicity, language, and gender
- Strategy: Same analytical/modeling approach but included interaction terms for subgroups of interest

# Results: Free/reduced lunch subgroup effects



# Results: Race/ethnicity subgroup effects

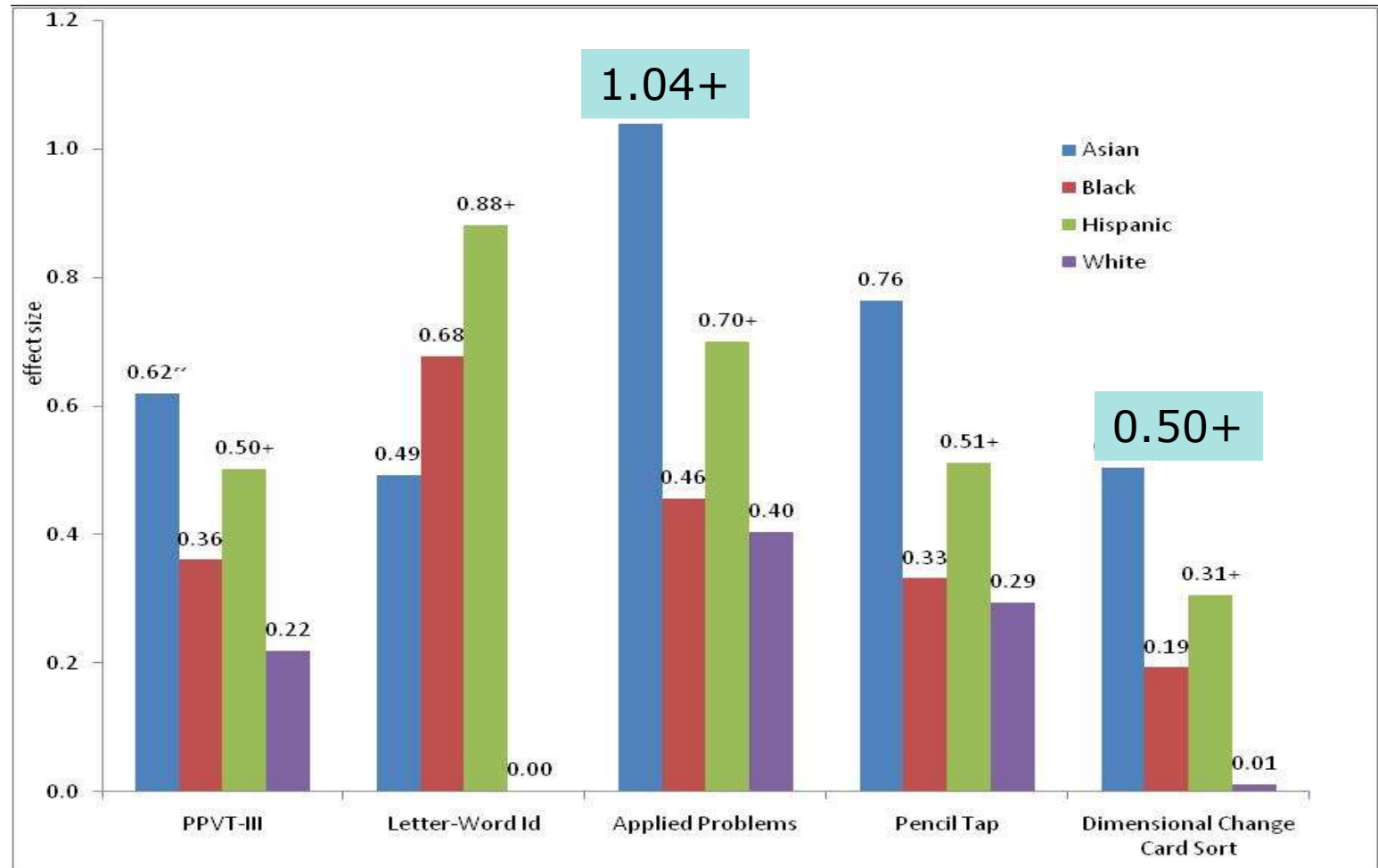


+ robust to bandwidth and functional form

~ not robust to bandwidth and/or functional form

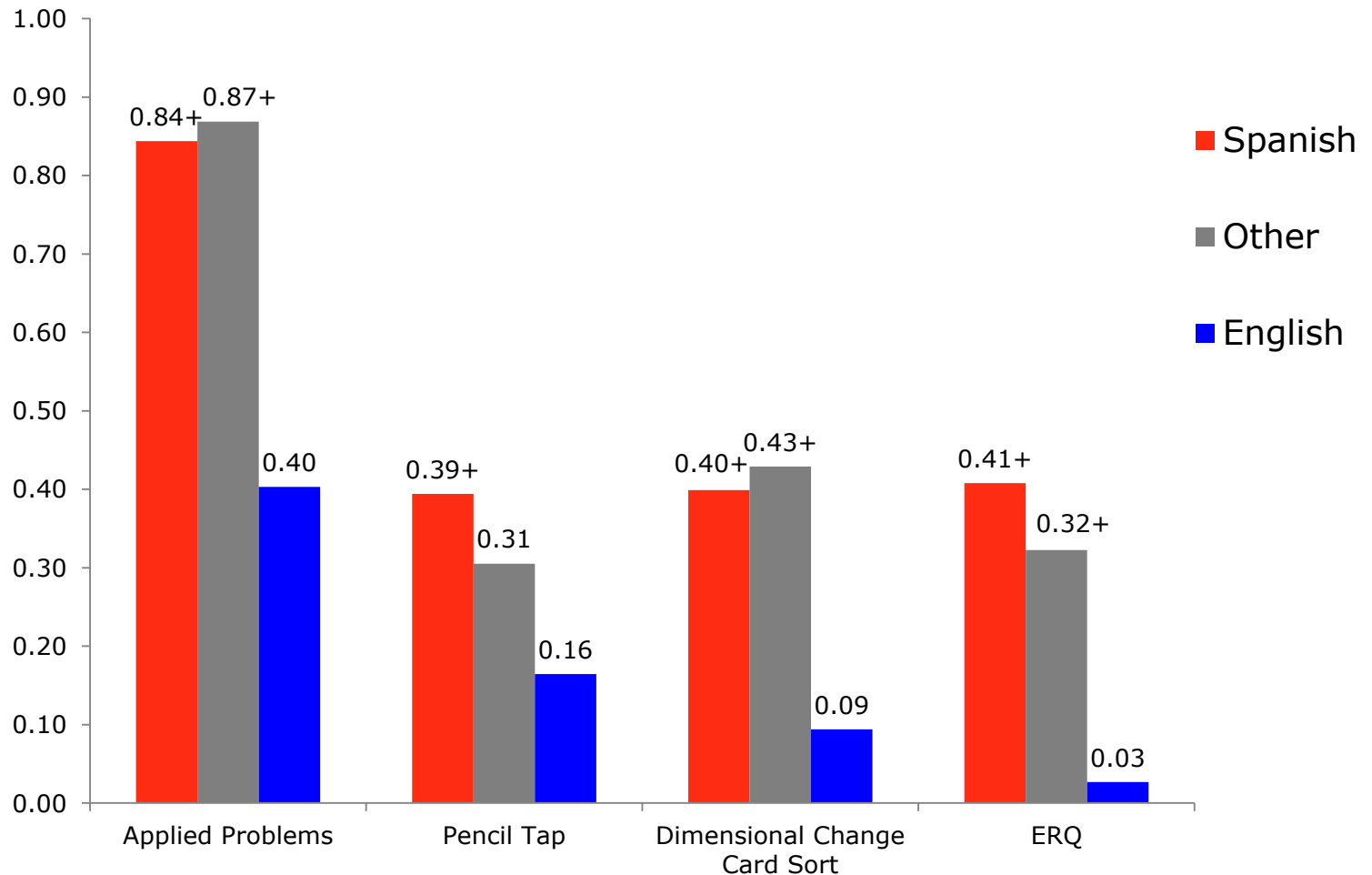


# Results: Race/ethnicity subgroup effects



+ robust to bandwidth and functional form  
~ not robust to bandwidth and/or functional form

# Results: Language subgroup effects



# Summary: Comparison of Boston effects to other recent public preK evaluations

	PPVT-III	Letter Word Identification	Applied Problems	REMA Short
<b>Boston</b>	<b>0.44***</b>	<b>0.62***</b>	<b>0.59***</b>	<b>0.50***</b>
Tulsa 2005	--	0.80***	0.38*	--
Tulsa 2008		0.99***	0.36***	
Michigan	-0.16	--	0.47*	--
New Jersey	0.36*	--	0.23*	--
South Carolina	0.05	--	--	--
West Virginia	0.14	--	0.11	--
Oklahoma	0.29*	--	0.35	--
New Mexico, Y1	0.35+	--	0.38+	--
New Mexico, Y2	0.25+	--	0.50+	--
New Mexico, Y3	0.17+	--	0.43+	--

\*\*\*p<0.001; \*\*p<0.01; \*p<0.05

+ results statistically significant but level of significance not reported.

Citations: Tulsa (Gormley, Gayer, Phillips, & Dawson, 2005; Gormley, Phillips, & Gayers, 2008); MI, NJ, SC, WV, OK (Wong et al., 2007); NM (Hustedt, Barnett, Jung & Goetze, 2009).

Note: All cited studies use the standard deviation of the control group as the denominator in calculating effect sizes. Boston models all use a bandwidth of 365 days and linear functional form between the outcome and age.

# Summary: Mathematics, Language, and Literacy

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- Largest increases to date on vocabulary and mathematics in evaluations of public prekindergarten at scale
- Investment in curricula specific to these domains produced *substantial and meaningful* gains
  - fidelity-to-curricula data suggest curricula implemented reasonably well
  - consistent with theory and some empirical work (Clements, Sarama, Spitler, Lange & Wolfe, in press; Harrison, McLeod, Berthelsen, & Walker, 2009; NAEYC & NAECS/SDE, 2003)

# Summary: EF

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- Increases in executive function skills from targeting language and mathematics skills most likely due to the curricula
- Critical planning, attentional and self-regulation skills for later school success
  - Mechanism unclear but possibly due to spillover from cognitively focused curricula
  - Some parts of curricula align with EF, particularly math



# Summary: Emotional Development

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- Increase in emotion recognition
  - directly targeted by the OWL
- No impact on emotional outcomes that were not so strongly targeted by the curricula



# Limitations

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- Results only generalize to students at the cutoff
- Results only generalize to children whose parents agreed to let them participate
- Cannot definitively identify the causal mechanisms behind detected effects



# Implications: Policy and Practice

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- Adds to evidence base for publicly funded pre-k
  - First evidence of causal effect on EF and emotion recognition
- High quality coaching system can be implemented to support two curricula
- Math results particularly compelling
- Some evidence of larger effects for some subgroups on some assessments (particularly Latino) but benefits largely accruing to everyone
- Contributes to discussion around the choice between increasing access and improving quality





# Implications and next steps: BPS

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- Confirms the city's and district's investment in K1
- Confirms Dept of EC's teacher training, coaching, curricula and quality support decisions
- Next steps: Examining the longitudinal effects of K1
  - Fadeout effects common in EC programs; suggests importance of quality of K-3
  - Working with the Dept. of EC this year to develop a longitudinal database to examine this and other questions.

# Thank you!

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# Appendix: Comparison of features of pre-k programs evaluated using RD

Site	Targeted program?	Program auspices	Duration	Teacher education
Boston	no	public schools	Full day	BA degree
Tulsa	no	public schools	Varied	BA degree, with training in early education
Michigan	yes; at risk only districts where at least 40 percent of children qualified for subsidized lunch	public schools, Head Start programs, and private care centers	Half-day	BA degree, teachers in public schools
New Jersey	lunch	public schools	Full day	BA degree, with training in early education
South Carolina	yes; based on risk factors	public schools, Head Start programs, and private care centers	Half-day	BA degree, with training in early education
West Virginia	determined at the local level	public schools, Head Start programs, child care and private care centers	Varied	BA or AA degree with training in early education
Oklahoma	no	public schools, Head Start programs, and private care centers	Varied	BA degree, with training in early education

Citations: Tulsa (Gormley, Gayer, Phillips, & Dawson, 2005); MI, NJ, SC, WV, OK (Wong et al., 2007)