

**Title:** Thresholds in micro-features of quality in early education and care

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## Background

Decades of evidence on the role of early education and care programs points to the importance of classroom and program quality for children's early development (Mashburn et al., 2008; Phillips, Gormley, & Anderson, 2016; Weiland & Yoshikawa, 2013). In recent years, studies have begun to examine whether there are thresholds in these associations – that is, whether quality features are only associated with child outcomes above (or below) meaningful thresholds. The majority of these studies have focused on widely-used measures of global quality (Burchinal et al., 2016) and teacher-child interactions (Burchinal et al., 2010; Burchinal et al., 2016; Leyva et al., 2015).

More recently, researchers have begun to examine the micro-features of quality in children's early education and care environments that characterize distinct adult- and child-driven behaviors and experiences (Farran et al., 2017). However, there is little evidence about whether there are thresholds in the associations between these micro-features of quality and children's outcomes, and the degree to which these thresholds vary across different early education and care settings. The current study addresses these gaps by addressing the following questions:

- Are there thresholds in the associations between micro-features of quality and children's academic, language, and social-emotional skills?
- To what extent do thresholds in the associations between micro-features of quality and children's outcomes vary across different types of early education and care settings?

## Methods

### Sample

Data come from the first wave of a large-scale longitudinal study of young children in Massachusetts. The sample for the present analysis includes 1,676 three- and four-year-olds, as well as their early education providers. Children in the sample were on average 3.9 years old ( $SD = 0.55$ ) and 68.0 percent White, 9.3 percent Hispanic, and 4.9 percent Black. Children in the sample were in care in a variety of settings, including community center-based care, public school prekindergarten, Head Start, and family child care.

### Procedures and Measures

**Quality.** Quality was measured using the Teacher and Child Observation in Preschool (TOP/COP). The TOP/COP captures adult- and child-driven micro-features of quality, such as time spent in transitions, the quality of instruction, educator tone, and whether educators listened to children TOP/COP; Bilbrey, Vorhaus, & Farran, 2007; Farran & Anthony, 2014). Trained observers conducted a series of "sweeps" during which adult and child behaviors were recorded; information from these sweeps was aggregated to the classroom level. Eight particular practices,

known as the “Magic 8,” have been linked to children’s outcomes (Farran et al., 2017). In the present analysis, we focus on three Magic 8 practices: instructional quality, teacher tone, and child involvement.

**Child outcomes.** Direct assessments evaluated children’s academic, language, and social-emotional skills. Children’s academic skills were measured using the Letter Word Identification and Applied Problems subscales from the Woodcock Johnson (WJ-III; Woodcock, McGrew, & Mather, 2001). Language and literacy skills were measured using the Phonological Awareness Literacy Screener (PALS; Ford & Invernizzi, 2014) and Quick Interactive Language Screener (QUILS; Golinkoff et al., 2017). Social-emotional skills were measured using the Leiter-3 (Roid, Miller, Pomplun, & Koch, 2013), Pencil Tap (Blair, 2002; Diamond & Taylor, 1996), and the Minnesota Executive Function Scale (MEFS; Carlson & Zelazo, 2014).

### **Analysis Plan**

Following commonly-used procedures in the literature (e.g., Burchinal et al., 2016), we used a multi-step process to examine whether there were thresholds in the associations between micro-features of quality and children’s outcomes. Separate analyses were conducted for each of the three quality features.

First, we use an *a priori* approach to examine whether there are differences in the associations between micro-features of quality and child outcomes at different ranges of quality. We first estimated preliminary, unconditional polynomial regression models predicting child outcomes as a function of quality to determine the possible number of thresholds. We then estimated piecewise linear regression models predicting child outcomes a function of quality. Where the preliminary analyses indicated the presence of one potential threshold, associations between quality and child outcomes were allowed to differ at high and low levels of quality. Where the preliminary analyses indicated the presence of two thresholds, associations were allowed to differ at high, medium, and low levels of quality.

Next, we used an empirical approach to identify the locations of thresholds in the associations between quality and child outcomes by estimating a series of b-spline regression models. This approach extends the piecewise model by estimating multiple connected segments defined by non-linear functions. Following the conventions in the literature, we define an overall cubic function, and allow the level of cubic change to differ between the 25<sup>th</sup>, 50<sup>th</sup> and 75<sup>th</sup> percentiles.

### **Preliminary Results**

Results indicate several non-linear associations between the micro-features of quality and child outcomes. Results of piecewise linear regression models indicate that instructional quality (which ranges from low level instruction to high inferential learning) was more strongly associated with children’s literacy skills and executive function at higher levels of quality. For

example, instructional quality was not associated with children's beginning sound awareness at levels of quality below the sample median (including primarily low-level instruction). However, we observed a positive association between these measures at levels of quality above the sample median (including more basic skills instruction and inferential learning). These results of b-spline regression models similarly indicate little association between instructional quality and these child outcomes at lower levels of quality.

Child involvement was also more strongly associated with children's literacy skills and executive function at higher levels of quality. Similarly, educator tone was more strongly associated with executive function and social-emotional skills at higher levels of quality. In contrast, associations between educator tone and children's math and literacy skills were strongest at medium, rather than high, ranges of quality. Additional analyses will examine whether there are differences in the location of these thresholds for different types of early education and care settings.

### **Conclusion**

A better understanding of the associations between children's early outcomes and quality features in their early education and care environments can provide a better of understanding of mechanism through which these environments support children's longer-term outcomes. The final presentation will discuss implications for early education and care policy.

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## Tables and Figures

Table 1. Results of piecewise linear regression: Instructional quality

	(1) WJ: AP	(2) WJ: LWI	(3) PALS: BSA	(4) PALS: RA	(5) QUILS	(6) MEFS	(7) PT	(8) Leiter: Cog./Soc.	(9) Leiter: Emo./Reg.
Instructional quality: 1	0.05 (0.13)	-0.04 (0.20)	-0.25 <sup>+</sup> (0.13)	-0.02 (0.13)	0.01 (0.13)	0.08 (0.14)	0.29 (0.20)	0.25 <sup>+</sup> (0.15)	0.14 (0.16)
Instructional quality: 2	0.13 (0.20)	0.49 (0.36)	0.65 <sup>**</sup> (0.21)	0.22 (0.21)	0.08 (0.21)	0.15 (0.22)	-0.24 (0.37)	-0.14 (0.24)	-0.20 (0.26)
Instructional quality: 3		-0.41 (0.35)					0.94 <sup>**</sup> (0.36)		
<i>p</i> -value: I1 vs. I2	0.791	0.303	0.003	0.434	0.789	0.825	0.306	0.257	0.354
<i>p</i> -value: I1 vs. I3		0.308					0.086		
<i>p</i> -value: I2 vs. I3		0.157					0.074		
<i>N</i>	1566	1582	1518	1513	1432	1378	1403	1637	1632

*Note:* WJ: AP = Woodcock-Johnson Applied Problems; WJ: LWI = Woodcock Johnson: Letter-Word Identification; PALS: BSA = PALS: Beginning Sound Awareness; PALS: RA = PALS: Rhyme Awareness; PT = Pencil Tap; Leiter: Cog./Soc. = Leiter: Cognitive/Social Composite; Leiter: Emo. Reg. = Leiter: Emotions/Regulation Composite Score.

Standard errors in parentheses. Models include random intercepts for provider. All models control for program type and child covariates. Child covariates include child age, child gender, child race/ethnicity, child language, child special education status, child health, household reading activities, parent marital status, parent education, family income, family use of social services, number of individuals in the household, and number of children in the household. For models with two segments, knot point at 50<sup>th</sup> percentile. For models with three segments, knot points at 33<sup>rd</sup> percentile and 66<sup>th</sup> percentiles. <sup>+</sup>  $p < 0.10$ , <sup>\*</sup>  $p < 0.05$ , <sup>\*\*</sup>  $p < 0.01$ , <sup>\*\*\*</sup>  $p < 0.001$ .

Table 2. Results of estimating piecewise linear regression models: Educator tone

	(1) WJ: AP	(2) WJ: LWI	(3) PALS: BSA	(4) PALS: RA	(5) QUILS	(6) MEFS	(7) PT	(8) Leiter: Cog./Soc.	(9) Leiter: Emo./Reg.
Teacher tone: 1	-0.43 (0.34)	-0.02 (0.19)	0.32 (0.20)	-0.00 (0.36)	-0.35 (0.35)	-0.12 (0.37)	-0.58 (0.36)	-0.64 (0.40)	-0.41 <sup>+</sup> (0.23)
Teacher tone: 2	0.51** (0.19)	0.03 (0.13)	0.07 (0.14)	0.48* (0.20)	0.40* (0.20)	0.22 (0.21)	0.32 (0.20)	0.19 (0.22)	0.22 (0.17)
Teacher tone: 3	-0.15 (0.20)			-0.12 (0.22)	0.05 (0.21)	-0.15 (0.23)	0.20 (0.22)	-0.29 (0.25)	
<i>p</i> -value: T1 vs. T2	0.044	0.846	0.393	0.321	0.122	0.500	0.072	0.122	0.066
<i>p</i> -value: T1 vs. T3	0.462			0.769	0.306	0.955	0.058	0.432	
<i>p</i> -value: T2 vs. T3	0.050			0.093	0.318	0.339	0.736	0.230	
<i>N</i>	1573	1589	1525	1520	1439	1385	1409	1646	1641

*Note:* WJ: AP = Woodcock-Johnson Applied Problems; WJ: LWI = Woodcock Johnson: Letter-Word Identification; PALS: BSA = PALS: Beginning Sound Awareness; PALS: RA = PALS: Rhyme Awareness; PT = Pencil Tap; Leiter: Cog./Soc. = Leiter: Cognitive/Social Composite; Leiter: Emo. Reg. = Leiter: Emotions/Regulation Composite Score.

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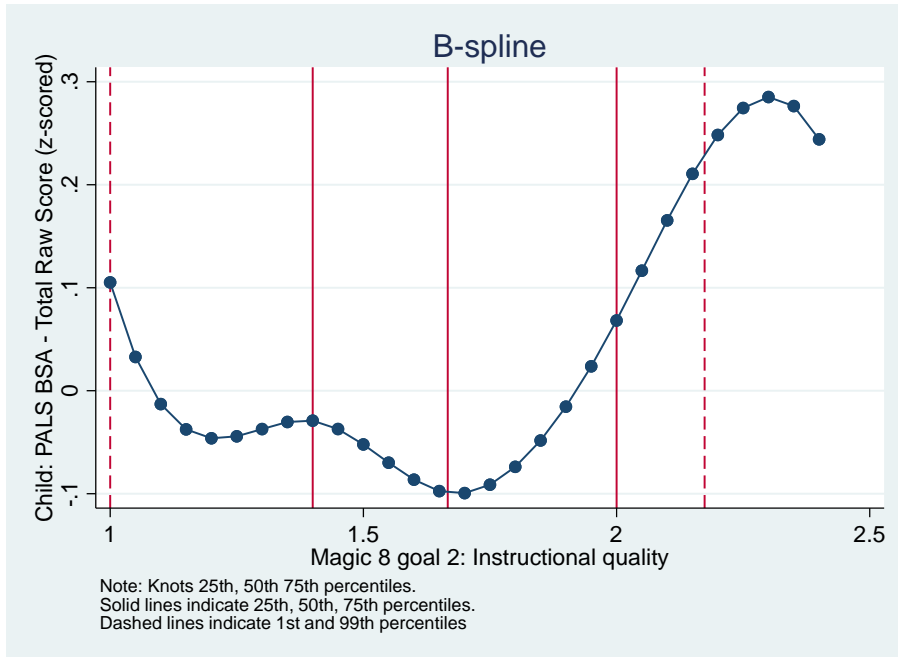


Table 3. Results of estimating piecewise linear regression models: Child involvement

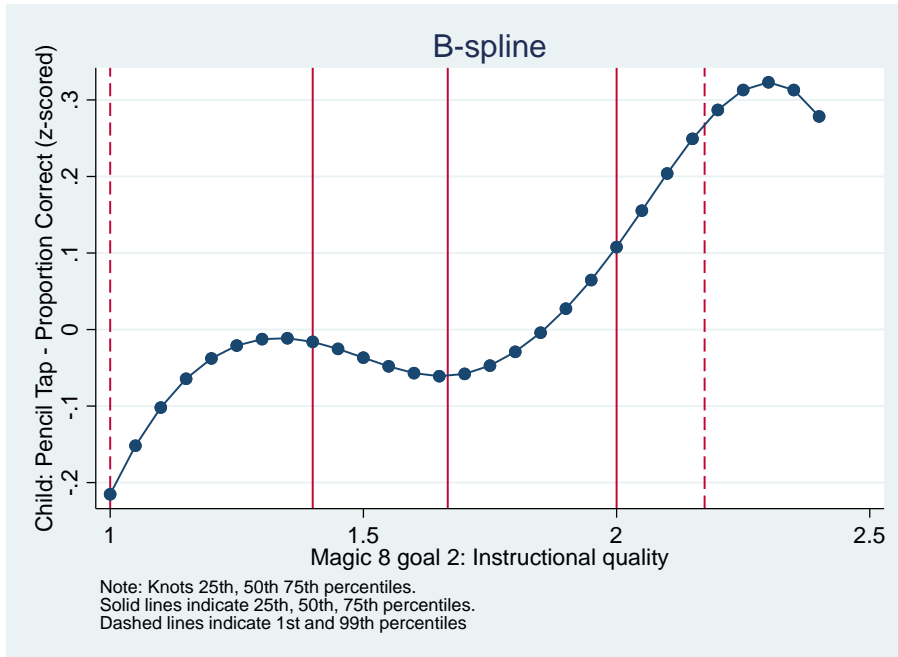
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
	WJ: AP	WJ: LWI	PALS: BSA	PALS: RA	QUILS	MEFS	PT	Leiter: Cog./Soc.	Leiter: Emo./Reg.
Child involvement: 1	.0026 (0.122)	-0.269 (0.228)	-0.155 (0.129)	-0.055 (0.130)	-0.020 (0.126)	0.081 (0.138)	-0.207 (0.134)	0.006 (0.146)	-0.034 (0.151)
Child involvement: 2	0.134 (0.097)	0.133 (0.147)	0.219* (0.104)	0.288** (0.103)	0.147 (0.097)	0.190+ (0.110)	0.230* (0.103)	0.092 (0.116)	0.024 (0.122)
Child involvement: 3		-0.073 (0.154)							
<i>p</i> -value: I1 vs. I2	0.473	0.213	0.055	0.079	0.365	0.601	0.027	0.693	0.797
<i>p</i> -value: I1 vs. I3		0.451							
<i>p</i> -value: I2 vs. I3		0.421							
<i>N</i>	1573	1589	1525	1520	1439	1385	1409	1646	1641

*Note:* WJ: AP = Woodcock-Johnson Applied Problems; WJ: LWI = Woodcock Johnson: Letter-Word Identification; PALS: BSA = PALS: Beginning Sound Awareness; PALS: RA = PALS: Rhyme Awareness; PT = Pencil Tap; Leiter: Cog./Soc. = Leiter: Cognitive/Social Composite; Leiter: Emo. Reg. = Leiter: Emotions/Regulation Composite Score.

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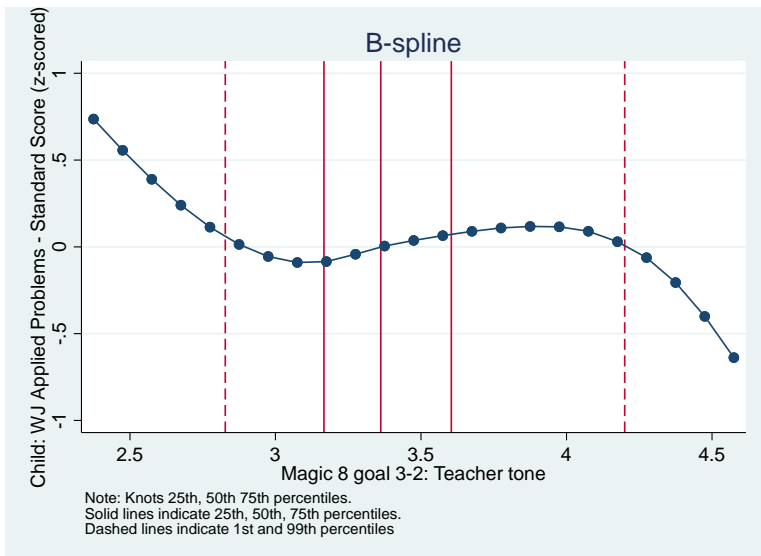


a) Instructional Quality and PALS: Beginning Sounds Awareness

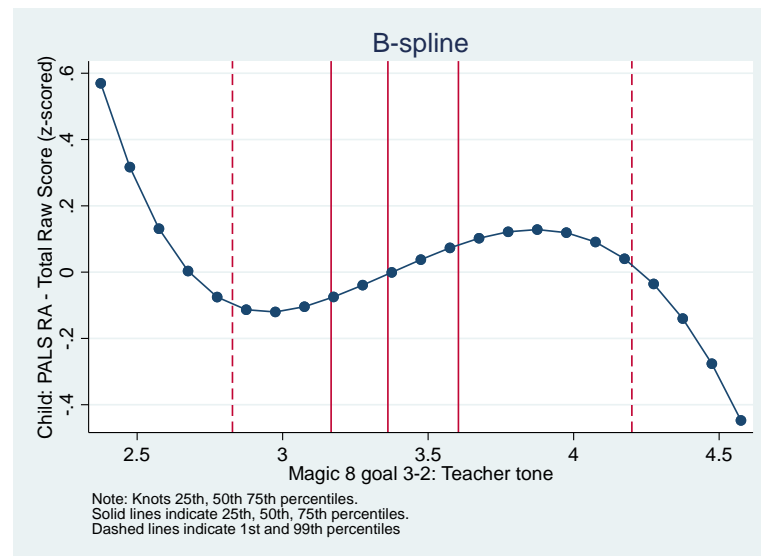


a) Instructional Quality and Pencil Tap

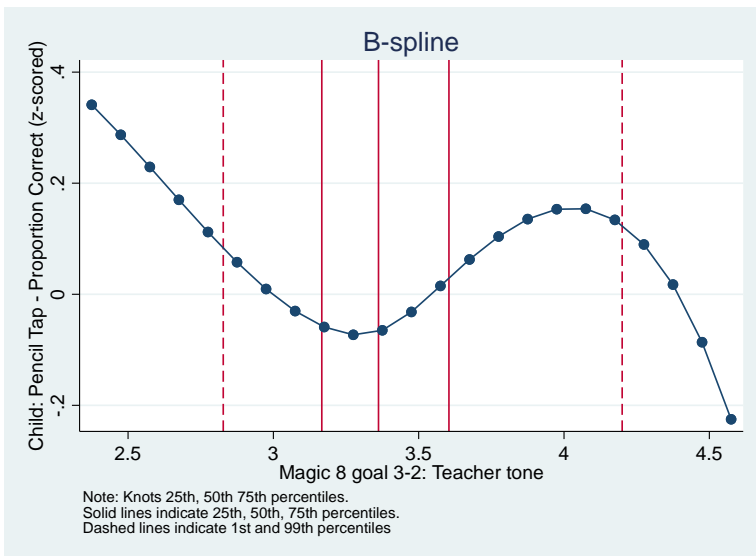
Figure 1. Results of b-spline regression models examining the association between instructional quality and child outcomes



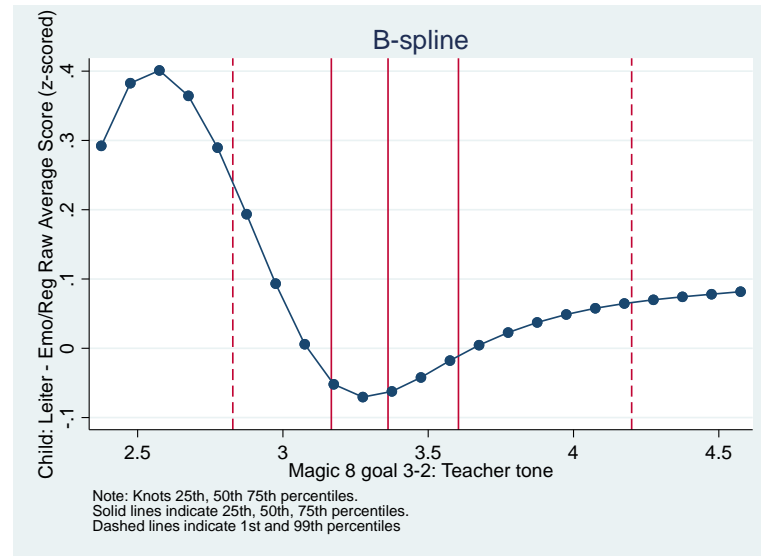
a) Educator Tone and Woodcock-Johnson: Applied Problems



b) Educator Tone and PALS: Rhyme Awareness

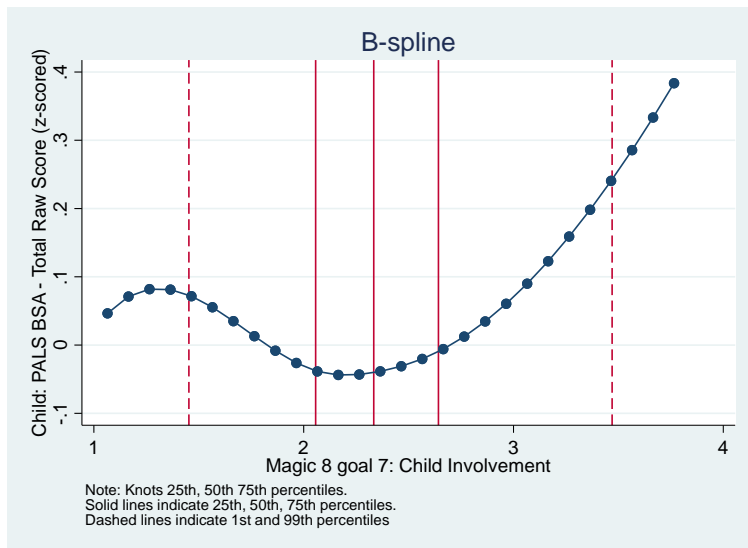


c) Educator Tone and Pencil Tap

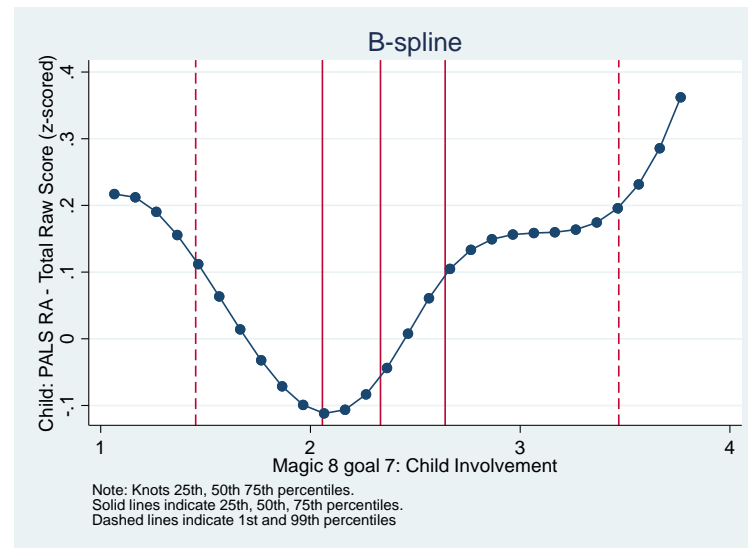


d) Educator Tone and Leiter: Emotion Regulation

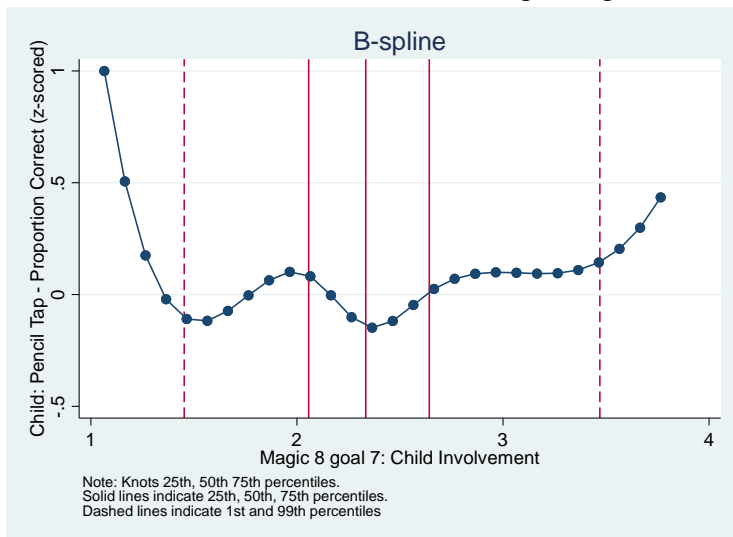
Figure 2. Results of b-spline regression models examining the association between educator tone and child outcomes



a) Child Involvement and PALS: Beginning Sound Awareness



b) Child Involvement and PALS: Rhyme Awareness



c) Child Involvement and Pencil Tap

Figure 3. Results of b-spline regression models examining the association between child involvement and child outcomes