



# HHS Public Access

Author manuscript

*Learn Individ Differ.* Author manuscript; available in PMC 2017 August 01.

Published in final edited form as:

*Learn Individ Differ.* 2016 August ; 50: 73–82. doi:10.1016/j.lindif.2016.07.005.

## Do Children's Learning-Related Behaviors Moderate the Impacts of an Empirically-Validated Early Literacy Intervention?

**Sara A. Hart**

Florida State University and Florida Center for Reading Research

**Shayne B. Piasta and Laura M. Justice**

The Ohio State University and Crane Center for Early Childhood Research and Policy

### Abstract

The present study included 314 children who had been involved in Project STAR, and explored how two learning-related behaviors, interest in literacy and effortful control, moderated the impact of the literacy intervention on reading outcomes. Results indicated significant associations of both learning-related behaviors with reading, with the children with the highest literacy interest and effortful control in the intervention group showing the highest reading outcomes. These results indicate that accounting for a greater breadth of possible moderators of intervention impacts is an important area to explore.

### Keywords

literacy intervention; effortful control; interest in literacy; moderators; reading

---

In the broader field of human development, there is evidence that individuals vary in whether and/or the degree to which they are affected by environmental exposures, a phenomenon called the diathesis-stress/dual-risk model (see Belsky & Pluess, 2009). Evidence supporting this model indicate that some individuals are more vulnerable to environmental stressors, measured by an individual's characteristic (e.g., temperament, behavior) moderating an environmental influence. Within the field of education, there is consistent evidence suggesting that the individual characteristics that a child brings into the classroom, including both cognitive and learning-related behaviors, can have an interactive effect with the instruction received in the classroom. This phenomenon is commonly referred to as child-by-instruction interaction or aptitude-by-treatment interaction (Cole & Dale, 1986; Connor, Morrison, & Katch, 2004; Kanfer & Ackerman, 1989; Speece, 1990). This hypothesis, which has been explored for its potential in the educational fields as well as health sciences (see Caspi & Bell, 2004), asserts that treatment outcomes reflect the match (or lack thereof) between characteristics of the individual and the intervention provided. Said

---

Corresponding Author: S.A.Hart, 1107 W. Call St., Tallahassee, FL 32306, hart@psy.fsu.edu, 850-645-9693.

**Publisher's Disclaimer:** This is a PDF file of an unedited manuscript that has been accepted for publication. As a service to our customers we are providing this early version of the manuscript. The manuscript will undergo copyediting, typesetting, and review of the resulting proof before it is published in its final citable form. Please note that during the production process errors may be discovered which could affect the content, and all legal disclaimers that apply to the journal pertain.

another way, for some individuals, a certain characteristic shows a different relation to an outcome variable in one treatment than it does in another (Snow, 1991). In the educational field, the potential value of linking treatment to child-level characteristics has gained momentum in recent years as a result of a series of investigations that involve carefully mapping reading instruction to children's specific needs, finding that this leads to accelerated early reading growth (Connor et al., 2009).

Early work on aptitude-by-treatment interactions argued that treatments are most effective when they are tailored not only to an individual's cognitive factors but also their motivational factors (Kanfer & Ackerman, 1989). Motivational theorists, in particular, argued that one's performance on a task (or responsiveness to an intervention) should reflect cognitive abilities, motivational factors, and the interplay among the two. To this end, our interest in the present work is to consider how other child-level factors, namely those representing their learning-related behaviors, might moderate children's reading outcomes within an empirically validated early-literacy intervention added as a supplement to typical classroom instruction. Learning-related behaviors is a general term that describes how children approach opportunities to learn within the classroom, as represented by their motivation towards participating in and completing an activity and their ability to maintain their focus during that activity and limit distractions (see Stipek, Newton, & Chudgar, 2010).

On the basis of the hypothesized child-by-instruction interactions, we would presume that individual characteristics of children should interact with more intensive educationally-based interventions as they do with typical instruction (e.g., Peterson & Janicki, 1979). Similar to the recent work regarding individual differences in response to instruction, in which children receive additional tiers of support in conjunction with typical classroom instruction, researchers have identified specific closely related cognitive factors which moderate response to intervention, particularly phonological awareness (see Fletcher et al., 2011; Al Otaiba & Fuchs, 2002; Vellutino et al., 1996). Different than this work examining closely related cognitive factors, little work could be found which examined more broadly defined "learning-related behaviors" influencing treatment outcomes.

There have been some efforts to understand children's responsiveness to interventions beyond characteristics of the child herself. For instance, distal from the child, aspects such as teacher knowledge (Connor, Son, Hindman, & Morrison, 2005; Piasta, Connor, Fishman, & Morrison, 2009) and general school environment (Rutter & Maughan, 2002) have been suggested to significantly interact with child outcomes due to treatment. Also, as mentioned previously, there is a literature pointing to the importance of closely-related cognitive skills, such as phonological awareness and letter knowledge, with child outcomes due to treatment (e.g., Vellutino et al., 1996; Vellutino, Scanlon, Zhang & Schatschneider, 2007). However, the literature is sparse in research examining child-specific factors encompassing learning-related behaviors, such as motivation and effortful control, which may affect treatment outcomes. What few reports exist (e.g., Deault, Savage, & Abrami, 2009; for review, Snow, 1992) were conducted typically outside of a formal randomized controlled trial framework, thus resulting in many potential confounds. A notable exception indicated that children's attentional skills moderated the extent to which explicit print instruction contributed to children's literacy learning (McGinty, Justice, Piasta, Kaderavek, & Fan, 2012).

Our interest in exploring learning-related behaviors and their contribution to intervention outcomes is supported by research showing they are an important part of learning to read (Guthrie & Wigfield, 1999; Guthrie, Wigfield & VonSecker, 2000). For example, children's interest towards reading (i.e., literacy interest or literacy motivation) and their effortful control make strong contributions to children's reading development (Valiente, Lemery-Chalfant, & Swanson, 2010; Wigfield, 2010). The amount of personal interest for reading activities is typically a stable predisposition that develops over time and is related to grade outcomes, even when controlling for ability (Schiefele & Csikszentmihalyi, 1994). Moreover, it has been suggested that literacy interest leads to unconscious selective attention towards a reading activity (Hidi, 1990). From this, it has been proposed that information which is considered interesting is processed differently than information which is not considered of interest (Hidi, 1990). Therefore, higher literacy interest may result in a totally different learning situation for a child compared to one with low interest in reading (Hidi, 1990).

Interest towards literacy has consistently been shown to be associated with literacy, and subsequent reading, outcomes, even beyond important other predictors of literacy. For example, child engagement during a parent-child book reading activity at 2 years, a proxy for child interest towards reading, was associated with higher literacy outcomes at 4.5 years, beyond language skills and exposure to direct instruction in reading (Crain-Thoreson & Dale, 1992). In another study, a direct measure of child interest accounted for 3% of unique variance in literacy outcomes in 5-year-old children, beyond phonological awareness, vocabulary, and levels of home literacy (Frijters, Barron & Brunello, 2000). Sénéchal, LeFevre, Hudson and Lawson (1996) reported that children's interest towards storybook reading, measured by children's requests for reading, accounted for unique variance in vocabulary outcomes, after controlling for home literacy and socioeconomic status. Recently, Sparks and Reese (2013) found that preschool children's interest towards literacy was related to literacy and early-reading outcomes such as print concepts and decoding, above socioeconomic status and vocabulary. In general, high literacy interest can influence literacy outcomes and subsequent reading performance, and is specifically associated with better learning strategies, sustained attention to the task and greater reading comprehension (see Wigfield, 2010, for review).

Similar to literacy interest, the temperament trait effortful control has been linked with literacy, and subsequent reading, outcomes (Keogh, 2003) and is considered an important early learning-related behavior (Stipek et al., 2010). Effortful control, commonly considered a proxy for self-regulation, is linked with the ability to control behavior and attention as needed to complete difficult tasks (Posner & Rothbart, 2006), which is associated with reading achievement outcomes (Deater-Deckard, Mullineaux, Petrill, & Thompson, 2009). In general, it is hypothesized that the ability to focus on relevant information and inhibit distractions, both attributed to high effortful control, aid in the learning process (NICHD Early Child Care Research Network, 2003). In a study of elementary school-aged children, effortful control was linked to children's general school achievement, beyond previous school achievement and socioeconomic status (Valiente, Lemery-Chalfant, Swanson & Reiser, 2008). Blair and Razza (2007) found that effortful control, measured in preschool,

accounted for unique variance in kindergarten literacy outcomes, beyond executive function and false belief. Also, Liew, McTigue, Barrois and Hughes (2008) reported that effortful control measured in first grade uniquely predicted third grade reading outcomes beyond covariates including IQ, socioeconomic status, and ethnicity. In general, effortful control is considered to be very important in early school readiness and maintains its influence on achievement outside of cognitive ability and family factors (Ladd, Birch, & Buhs, 1999; Lewit & Baker, 1995).

Despite the literature suggesting that these two learning-related behaviors, namely literacy interest and effortful control, are important independent predictors of reading outcomes, the relationship between the two has been underexplored. One report suggested that children with higher effortful control tend to rate liking school more, possibly because they are more capable of managing emotion in school and have a stronger support system as they tend to be liked more by peers and teachers, resulting in greater academic success (Valiente, Lemery-Chalfant, & Castro, 2007). To our knowledge, the relation between literacy interest and effortful control has yet to be explored within an intervention framework. If it is the case that they both predict children's reading outcomes independently and interactively, then it stands to reason that these learning-related skills might be important moderators of treatment outcomes. For instance, we might anticipate that children with high literacy interest and/or high effortful control would benefit more from being in an intensive literacy treatment compared to similar children receiving typical instruction. This work makes an important contribution to the literacy intervention literature, as the movement towards a greater awareness of learning-related behaviors that affect academic outcomes increases (e.g., Valiente et al., 2010).

The present research uses data available from a larger multi-site randomized controlled trial (RCT) designed to improve preschool children's literacy skills in advance of kindergarten entry (Justice, McGinty, Piasta, Kaderavek, & Fan, 2010). The intervention, Project STAR (Sit Together and Read), involved a 30-week preschool book reading treatment which consisted of whole-class shared-reading sessions in which teachers implemented print-focused instruction within the context of shared reading with their students (Justice, Kaderavek, Fan, Sofka, & Hunt, 2009). The treatment involves teachers' adherence to a systematic scope and sequence of instruction that teachers follow using various tools to promote implementation fidelity (in-service training, on-going monitoring based on fidelity checks, teachers' manual with book inserts to guide sessions). On the basis of consistent efficacy data showing the positive impacts of this treatment (see Justice & Ezell, 2000; Justice & Ezell, 2002), the RCT involved a more generalized test of intervention effects with implementation by teachers working in a variety of preschool settings. Treatment teachers adhered to the print referencing instructional scope and sequence, with comparison classrooms reading project storybooks using their normal reading approach, thus allowing for direct tests of causal effects. Initial work suggested that children in the experimental classrooms reported greater positive gains in print knowledge ( $d = 0.21$ ) during their preschool year over the comparison classrooms (Justice et al., 2010). Moreover, the positive gains continued through kindergarten ( $d = 0.21$  to  $0.26$ ) and first grade ( $d = 0.26$  to  $0.31$ ), indicating that children who were exposed to this treatment at preschool were better readers (based on measures of decoding and comprehension) than those in the comparison group

(Piastra, Justice, McGinty, & Kaderavek, 2012). Given the multiple tests of this, and similar, treatments, including evaluation by independent research teams (Lovelace & Stewart, 2007), STAR can be considered an empirically validated intervention for providing early-literacy intervention.

Studies of the STAR intervention to date have largely provided estimates of mean effects, with no attention to how children's learning-related behaviors may moderate the impacts of this intervention. However, there are important reasons to anticipate that children's literacy interest and/or effortful control might contribute to intervention impacts for children receiving the treatment. STAR sessions implemented by teachers require young children to participate in large-group read-aloud session two or four times per week in their classrooms, with an average group size of about 16 children. These sessions last about 20- to 30-minutes and provide opportunities for children to discuss with their teacher print-related features of the storybooks. Children in comparison classrooms also participate in reading sessions, in which their teachers read STAR storybooks using their normal reading style. However, because of the interactive and prolonged nature of it, the STAR reading sessions tend to be more demanding than the business as usual reading sessions implemented in comparison classrooms. Thus, we might expect children who are highly interested in literacy experiences, and/or who can sit still and attend for longer periods of time, to benefit substantially from the STAR intervention.

This paper represents exploratory secondary data analysis to test the idea that two specific learning-related behaviors, literacy interest and effortful control, can moderate the impact of an intervention. The main goal of the present paper was to test this idea, and explore whether literacy interest and effortful control moderate the impacts of early-literacy intervention based on measures of reading outcomes in kindergarten. As this work is exploratory, all different interactions among literacy interest, effortful control and intervention status were tested (e.g., effortful control by treatment status, literacy interest by effortful control by treatment status). Given the intensive nature of the intervention, which suggested that certain children may be able to attend better than others, it was hypothesized that an interaction would be significant, particularly between the learning-related behaviors of interest in literacy and effortful control, and intervention status, and therefore secondary analyses would involve post-hoc contrast tests to further explore the relations. We did this through three exploratory research questions. The first two research questions concern the role of literacy interest and/or effortful control in moderating child outcomes in the STAR versus comparison groups, and the third specifically focuses on the role of these sources of individual differences on response to intervention (across the treatment and comparison groups). Questions were as follows: (1) To what extent are individual differences in learning-related behaviors, specifically literacy interest and/or effortful control, associated with children's reading outcomes in kindergarten after receiving a supplemental literacy treatment in preschool? (2) To what extent are individual differences in literacy interest and/or effortful control associated with children's reading outcomes in kindergarten after business-as-usual instruction in preschool, modeling a typical classroom situation? (3) What is the relation of individual differences in literacy interest and/or effortful control to reading outcomes across intervention status? Particularly, is there a combination of literacy interest

and effortful control that contributes to the difference between the treatment group and comparison group in reading outcomes at kindergarten?

## Method

### Participants

Project STAR was a multi-site, multi-wave project conducted during the 2004-5 or 2005-6 academic years and involving the participation of 85 preschool teachers and 551 children sampled from these classrooms (Justice et al., 2010). Recruitment for Project STAR began with direct recruitment of lead classroom teachers prior to the start of the academic year through locally-held information sessions and informational flyers distributed through their preschool centers. Recruitment focused on teachers working within preschool programs that prioritized enrollment of children considered at risk for future reading difficulties due to socioeconomic risk factors (e.g., Head Start, Title I). Interested teachers were considered enrolled after attending a locally-held information session and completing informed consent ( $n = 85$ ) prior to the start of the school year. These participating teachers then distributed project information and consent forms to parents of children enrolled in their classrooms at the start of the year and parents were asked to return the consent form within two weeks to be considered for participation in the project. All consented children were eligible for study participation if they also met inclusionary criteria, which specified that eligible children were between 3 years, 6 months and 4 years, 11 months old upon study entry (October 1 of the academic year), did not have an individualized education plan for cognitive or social/emotional disability, and were able to be tested in English. From the eligible pool of children, approximately six children per classroom (range = 2 – 13) were randomly chosen to be enrolled in the project as participants; the sample size for children per classroom was estimated from a priori power analyses. Consistent with the study's focus on socio-demographically at-risk children, there was a positive skew in family demographics, with most families reporting an annual income below \$30,000 (56%) and only 4.5% of families earned above \$65,000 per year (Justice et al., 2010).

For the present study, complete data was available for 314 children ( $n=216$  in treatment group) from the larger project, to include end-of-kindergarten reading outcomes. Therefore, all analyses used this subsample, which included 160 boys and 154 girls with a mean age of entry into the project of 53.47mnths (range = 47.00-60.00mnths). According to parent report, 39.80% of the children were African American/Black, 5.70% were Hispanic, 42.70% were White, and the remainder was mixed or other race/ethnicity. Similar to the larger project, most parents reported an annual income below \$30,000 (63.5%), suggesting a positive skew in socioeconomic status. Complete descriptive statistics of the participants, including by study group, are in Table 1.

### Materials and Procedures

Prior to the start of the academic year (2004-5 or 2005-6), classrooms were randomly assigned into one of three study groups (“High-Dose Print Referencing”, “Low-Dose Print Referencing”, “Regular Reading”). For all three groups, teachers received the same set of 30 commercially-available storybooks and were asked to read one book repeatedly per week

(either two or four times) in whole-group reading sessions in a specified order. As shown in prior work, all teachers demonstrated strong fidelity to their randomly assigned treatment protocol (Justice et al., 2010; McGinty, Breit-Smith, Fan, Justice, & Kaderavek, 2011). All initial research with human subjects, and subsequent secondary data analysis, were done in compliance with APA ethical standards in the treatment of human samples.

**Print-Referencing**—Teachers in the High-Dose Print Referencing group read the same book four times weekly with their whole class for a 30-week period, thus implementing a total of 120 whole-class read-alouds. During each session, the teacher targeted within the read-aloud two designated, print-related instructional objectives according to a specified scope and sequence. This scope and sequence was designed to ensure systematic and consistent focus on each of the four domains of print knowledge development (i.e., knowledge of word, letters, print concepts, and print meaning). Teachers in the Low-Dose Print Referencing followed the same systematic, print-related instructional focus as the teachers in the High-Dose Print Referencing group, but they conducted two, rather than four, shared reading sessions each week; thus, these teachers implemented 60 read-alouds and provided a planned contrast for intensity of treatment. A full description of the intervention implemented has been published previously (Justice et al., 2009), and all materials are available in Justice and Sofka (2010)

**Comparison**—Teachers in the Regular Reading group conducted four whole-class shared reading sessions each week, using the same books as teachers in the Print Referencing groups, but were given no instructional directive about what to do during shared reading. Teachers in this group read books in a “business-as-usual” manner and prior research shows they incorporated very few print referencing techniques (Justice et al., 2010). There was clear differentiation in read-aloud discussions when comparing treatment teachers (both the High-Dose and Low-Dose groups) and the comparison-group teachers (Piasta et al., 2010). Similar to teachers in the High-Dose Print Referencing group, these teachers implemented 120 whole-class read-alouds in their classrooms over the academic year.

### Child Assessment and Measures

Up to four assessment sessions were completed to measure children’s early reading skills, two in the intervention year (fall and spring of the preschool year), and one each during the spring of the kindergarten (one-year follow-up) and first-grade years (two-year follow-up). For the present study, the primary outcome of interest is assessment of children’s reading skills conducted at one-year follow-up, when children were in kindergarten. At this time-point, effect-size indices showed that children who had received the high-dose STAR intervention had better decoding, spelling, and comprehension scores compared to those in the comparison group, and those in the low-dose STAR group had better decoding and spelling scores compared to those in the comparison group (Piasta, Justice, McGinty, & Kaderavek, 2012). Moderators of interest were children’s learning-related behaviors, namely literacy interest and effortful control, based on parent and teacher report collected in preschool (respectively).

**Kindergarten reading outcomes**—Kindergarten early reading outcomes were measured using three subtests of the Woodcock-Johnson Tests of Achievement III (Woodcock, McGrew, & Mather, 2001). *Letter-Word Identification* measures children's ability to recognize and name letters and words of increasing complexity. *Reading Fluency* measures children's ability to quickly read sentences and determine if the statement in the sentence is true or false within a 3-min time limit. Finally, *Passage Comprehension*, measures children's ability to understand increasingly long excerpts of text (from a sentence to a paragraph, using a cloze-format (i.e., complete the sentence) test of reading comprehension. Psychometric data on this measure and these subtests are well established (Woodcock et al., 2001). For purposes of parsimony, prior to analyses, raw scores for each subtest were combined into a single factor score, reading, using principal axis factoring (Eigenvalue = 2.11, 71% of variance explained). All three measures loaded highly onto the factor (factor loadings of .92, .77 and .83, respectively).

**Child learning-related behaviors**—Children's learning-related behaviors, based on measures captured in preschool concomitant with children's participation in the early-literacy intervention, reflected their literacy interest and effortful control. For literacy interest, three items from a parent questionnaire collected in fall of their children's preschool year were selected as indicators of children's literacy interest (How many times did your child ask to be read to last week? How many times did your child look at books on his/her own last week? and Do you think your child enjoys being read to?). These items were among a larger set designed to capture information about children's home literacy environment; items were derived from empirical reports (e.g., Frijters, Barron, & Brunello, 2000). These three items were combined using principal axis factoring to create a factor score of literacy interest (eigenvalue = 1.50, 50% of variance explained). Factor loadings were .74, .79 and .57, respectively, and Cronbach's alpha for these three items was .69.

For effortful control, teacher responses to the 12-item effortful control subscale of the Child Behavior Questionnaire-Very Short Form (Putnam & Rothbart, 2006) were used. This measure was completed by teachers about mid-way through the academic year for each study child in his/her classroom. Teachers responded to a series of statements about a child (e.g., When drawing or coloring, shows strong concentration; When building becomes very involved in what s/he is doing) based on a Likert-type scale of 1 to 7 (1 = extremely untrue of this child, 7 = extremely true of this child). The mean score for each of the 12 items was used to represent effortful control. For the present sample, Cronbach's alpha indicates high reliability among the items ( $\alpha = .85$ ).

**Analytic strategy**—As part of the greater Project STAR, random assignment occurred at the preschool classroom level, resulting in a nesting of children within preschool and subsequent kindergarten classrooms. Consistent with this data structure and with our theoretical research interests, Hierarchical Linear Modeling (HLM; Raudenbush & Bryk, 2002) was used as the analytic technique. Within this HLM framework, a two-level HLM model was explored, with children nested within their preschool classrooms (intraclass correlation = .12). The HLM model predicted reading from children's literacy interest, effortful control, intervention status, and the interactions among these three variables.



Reading was set as kindergarten reading levels only as Project STAR was a fully randomized control trial (RCT), so no pre-intervention differences in reading or demographics were expected (Shadish, Cook & Campbell, 2002). However, this assumption was explicitly tested as the present sample reflects a subset of participants from the full RCT sample, and no differential attrition due to intervention group status was found. No pretest (preschool) differences between the study groups were found for important measures of preschool literacy, including vocabulary ( $t(306) = 1.85, p = .07$ ; treatment group  $M = 49.83, SD = 16.27, n = 212$ ; comparison group  $M = 46.21, SD = 15.04, n = 96$ ), phonological awareness ( $t(153) = -1.39, p = .17$ ; treatment group  $M = 2.73, SD = 3.58, n = 211$ ; comparison group  $M = 3.46, SD = 4.62, n = 98$ ) and uppercase alphabet knowledge ( $t(306) = 0.17, p = .17$ ; treatment group  $M = 10.11, SD = 9.66, n = 211$ ; comparison group  $M = 9.92, SD = 9.13, n = 97$ ; see Piasta et al., 2012, for further description of these pretest measures). Additionally, there were no significant differences noted between the study groups in the present study for age ( $t(312) = -0.19, p = .85$ ), sex ( $\chi^2(1, N=314) = .25, p = .62$ ), English spoken at home ( $\chi^2(1, N=307) = .42, p = .52$ ), race-ethnicity ( $\chi^2(6, N=311) = 2.72, p = .84$ ), maternal education ( $\chi^2(8, N=303) = 13.81, p = .09$ ) and family income ( $\chi^2(17, N=293) = 25.44, p = .09$ ; Table 1).

Literacy interest and effortful control were grand-mean centered and entered as fixed effects. Additionally, we combined the Low-Dose Print Referencing and High-Dose Print Referencing groups into a single intervention status, dummy coded (1 = high- or low-dose treatment group; 0 = comparison group) and also entered as fixed effect. Previous findings support this data reduction approach, indicating no practical or significant differentiation in kindergarten outcomes as a function of the low- and high-dose variations (Piasta et al., 2012) nor for teachers' implementation of the intervention during the preschool year (Piasta et al., 2009). All modeling used Proc Mixed in SAS 9.4, including when significant interactions were detected which were probed by a series of post-hoc contrasts (Jaccard & Turrisi, 2003).

## Results

Descriptive statistics for children's kindergarten reading outcomes, literacy interest and effortful control in preschool are presented in Table 2. Pearson correlations between the measures were low and statistically significant, with the correlation between reading and literacy interest,  $r = .14 (p = .01)$ , between reading and effortful control,  $r = .23 (p = .00)$ , and between literacy interest and effortful control,  $r = .12 (p = .03)$ . Table 3 presents the results from the main HLM analysis. The model suggested a significant three-way interaction among literacy interest, effortful control, and intervention status, which significantly predicted child reading outcomes (coefficient = .39,  $p = .006$ ). No other interactions were significant. This suggested that children's learning-related behaviors of literacy interest and effortful control were associated with reading outcomes from the literacy intervention, and this may be different between the treatment and comparison group. The complete three-way interaction is displayed in Figure 1, although it should be noted that literacy interest is displayed using arbitrary conditional levels of "high" and "low" (one standard deviation above and below the mean, respectively) when in fact it is a continuous variable. This is done for display purposes, as well as to guide the post-hoc contrasts based

on these conditional levels of literacy interest and therefore does limit the conclusions which can be drawn concerning literacy interest (e.g., Aiken & West, 1991).

### Post-hoc contrast tests

Post-hoc contrasts were chosen to answer the three research questions posed by this study (see Table 4). The following lists the research questions with the accompanying post-hoc contrasts and results.

RQ 1: To what extent are individual differences in learning-related behaviors, specifically literacy interest and effortful control, associated with children's reading outcomes in kindergarten after receiving a supplemental literacy intervention in preschool?

The relation of children's learning-related behaviors to the reading outcome within the intervention group is displayed in Figure 2. Descriptively, there appeared to be a strong relation between effortful control and reading for children with high literacy interest, and perhaps also for children with low literacy interest. To test this, the absolute value of the simple slope of each of the two lines in Figure 2 was tested with the following post-hoc contrasts.

First, post-hoc contrast 1a considered the extent to which there was a significant relation of effortful control to reading for children with high literacy interest for those in the treatment group during preschool. The significant simple slope suggested that children in the treatment group with high literacy interest showed a positive relation between effortful control and reading outcomes. These children made higher outcomes with higher rates of effortful control (coefficient = 0.43,  $p = .001$ ; see Table 4 and grey dotted line of Figure 2).

Second, post-hoc contrast 1b considered the extent to which there was a significant relation of effortful control to reading for children with low literacy interest for those in the treatment group during preschool. The non-significant simple slope suggested that children with low literacy interest in the treatment group showed no significant association between effortful control and reading (coefficient = 0.09,  $p = .382$ ; see Table 4 and black thick line of Figure 2).

RQ 2: To what extent are individual differences in literacy interest and effortful control associated with children's reading outcomes in kindergarten after business-as-usual instruction in preschool, modeling a typical classroom situation? The relation of children's learning-related behaviors to the reading outcome within the comparison group is displayed in Figure 3. Looking descriptively at the Figure, the pattern of interaction appeared to be different than within the treatment group, such that the relation of effortful control to reading outcomes is greater for low literacy interest children than high. To statistically probe these relations, the same post-hoc contrasts on the simple slopes of the lines were analyzed as above, but within the comparison group.

First, post-hoc contrast 2a considered the extent to which there is a significant relation of effortful control to reading for children with high literacy interest who were in the contrast group during preschool. For children who experienced typical classroom literacy instruction

and had high literacy interest, there was no association between effortful control and reading outcomes (coefficient = 0.05,  $p = .687$ ; see Table 4 and grey dotted line of Figure 3).

Second, post-hoc contrast 2b considered the extent to which there is a significant relation of effortful control to reading for children with low literacy interest who were in the comparison group during preschool. Unlike children with high literacy interest above, for children with low literacy interest, there was a positive association between effortful control and reading (coefficient = 0.37,  $p = .000$ ; see Table 4 and black thick line of Figure 3). Children with low literacy interest in the comparison group achieved higher scores in reading with higher levels of effortful control.

RQ 3: What is the relation of individual differences in literacy interest and/or effortful control to reading outcomes across intervention status? Particularly, is there a combination of literacy interest and effortful control that contributes to the difference between the treatment group and comparison group in reading outcomes at kindergarten? To address this question, post-hoc probes across intervention groups were specifically analyzed to determine where the learning-related behaviors contributed to differences between the groups. Figure 1 represents the full three-way interaction, and post-hoc contrasts were chosen based on interesting relations suggesting group differences in outcome based on the Figure.

First, we explored possible independent moderation effects by each of literacy interest and effortful control alone between the intervention groups. In other words, is there a differential association of literacy interest to reading between the groups? And then, is there a differential association of effortful control to reading between the groups? Descriptively, it appeared that children in the treatment group with high literacy interest had higher reading scores than high literacy interest children in the comparison group (post-hoc 3a). As for low interest, it appeared that treatment group children with low literacy interest still performed better than comparison group children with low literacy interest (post-hoc 3b). The Figure did not suggest any possible group differences based on effortful control alone.

Second, we explored possible group differences based on the interaction of literacy interest and effortful control as moderators on reading. Said otherwise, is there a differential association of the interaction of literacy interest and effortful control to reading outcomes between the groups. Examining the Figure, it did appear that one group of children had the highest reading scores, namely children with high literacy interest and high effortful control in the treatment group, who seemed to score higher than children with the same beneficial learning-related behaviors in the comparison group (post-hoc 3d). Alternatively, it appears that children in the comparison group with low literacy interest and low effortful control had the lowest reading outcomes, even compared to their peers in the treatment group with the same learning-related behaviors (post-hoc 3e). Results from these post-hoc tests (which are of point differences, rather than simple slopes as above) are as follows:

Post-hoc contrast 3a. For children with high literacy interest, is there a difference between treatment and comparison groups in reading? The relation in Figure 1 between the children with high interest in the treatment group and comparison groups was significant (examining the difference between the bolded line and the dotted line at the zero point of effortful

control), coefficient =  $-0.36$ ,  $p = .031$  (see Table 4). This indicates that having high literacy interest was a significant moderator of response to intervention.

Post-hoc contrast 3b. For children with low literacy interest, is there a difference between treatment and comparison groups in reading? At the mean of effortful control, there was a non-significant difference between the solid line and the hashed line, representing low literacy interest between the intervention groups on reading outcomes (coefficient =  $-0.10$ ,  $p = .352$ ; Table 4). This suggests that low literacy interest does not contribute to differences in kindergarten reading scores due to intervention status.

Post-hoc contrast 3c. For children with high literacy interest and high effortful control, is there a difference between treatment and comparison groups in reading? In keeping with the trends seen in the Figure, post-hoc results suggested that indeed children who were high in literacy interest and high in effortful control in the treatment group had higher reading scores than children with the same high literacy interest and effortful control but in the comparison group (coefficient =  $-0.69$ ,  $p = .008$ ; Table 4)

Post-hoc contrast 3d. For children with low literacy interest and low effortful control, is there a difference between treatment and comparison groups in reading? The pattern in the Figure suggests that children with low literacy interest and low effortful control in the comparison group do more poorly on reading outcomes than their peers of similar low literacy interest and low Effort Control in the treatment group. This pattern was significant; children with low literacy interest and low effortful control in the comparison group perform significantly worse than children in the treatment group (coefficient =  $-0.34$ ,  $p = .010$ ; Table 4).

## Discussion

This study proposed to explore the learning-related behaviors of literacy interest and effortful control as individual difference moderators of intervention response in early childhood. Although it was hypothesized that at least one of the learning-related behaviors would moderate reading outcomes by intervention group status, the work was exploratory and tested all possibilities. The significant three-way interaction among literacy interest, effortful control and intervention group status on kindergarten reading outcomes suggested that the literacy interest and effortful control did moderate reading outcomes differentially within and between the intervention groups. The proposed three research questions involved exploratory post-hoc contrasts examining the role of literacy interest and effortful control within first the intervention group, second within the comparison group, and third between the groups, examining the fundamental question of the role of individual differences in behavior in response to intervention.

### Research question 1

The interactions in the treatment group are suggestive of how literacy interest and effortful control are associated with greater reading outcomes within an intensive classroom literacy intervention. The results from the post-hoc tests suggested that children who were high in literacy interest and effortful control showed the greatest reading outcomes in the treatment

group (post-hoc 1a). Interestingly, both high literacy interest and effortful control were necessary to show greater reading outcomes in the intervention group, as high effortful control alone was not enough for children with low literacy interest (post-hoc 1b). The intervention involved shared book reading in a whole class setting. This means that preschool-aged children had to concentrate while sitting in a large group of their peers, paying attention to their teachers referencing the text. Despite the effortful control necessary for this behavior, it was in fact the addition of literacy interest that resulted in greater reading scores in the intervention group. No level of effortful control mattered for reading outcomes when a child was not interested in literacy in general. It would seem that high effortful control is associated with the potential to score highly on kindergarten reading outcomes, but interest towards literacy is the necessary trait to have those high scores (although not sufficient). Therefore, this suggests that for the children receiving this intensive literacy intervention, higher reading outcomes are associated with not only being able to sit and pay attention to the intervention, but a high level of interest in the topic of the intervention was needed.

### Research Question 2

On the other hand, results in the comparison group were indicative of the influence of literacy interest and effortful control in typical literacy instructional environments. For this group, when children had high literacy interest, effortful control did not contribute to the association to reading outcomes (post-hoc 2a). For the children with low literacy interest, effortful control was strongly associated with reading outcomes (post-hoc 2b). These two results are initially confusing, but examining Figure 3 suggests that for the most part, children with low literacy interest (other than the few with very high Effort Control scores) have lower reading scores than children with high literacy interest. Therefore, in the comparison group, high literacy interest is sufficient to be associated with higher reading scores, but for children with low literacy interest, high effortful control is necessary to be associated with higher reading scores. Being interested in literacy is enough to be successful (compared to peers) within a typical classroom environment, but if a child is not interested in literacy, high effortful control can make up for the low interest. Effortful control has been linked generally with higher achievement outcomes (e.g., NICHD Early Child Care Research Network, 2003). The current finding may indicate that children with higher effortful control are just better overall learners in a typical classroom, no matter their interest in a particular subject matter.

### Research Question 3

Unlike the previous two research questions, exploring the role of literacy interest and effortful control as moderators of children's reading outcomes across the intervention groups allows for causal conclusions because Project STAR was a randomized control trial. In particular, we were able to explore if literacy interest and effortful control contributed to individual differences in response to intervention, specifically examining points in Figure 1 of interest which appeared to differentiate the two intervention groups due to behavioral trait differences.

As a first step, we considered the role of literacy interest and effortful control individually as sources of individual differences in response to intervention. The results suggested an important role for high literacy interest, especially contributing towards treatment group children getting higher reading scores over the comparison group. The post-hoc contrast supported this (post-hoc 3a). This indicates that high interest in literacy gives children in a literacy intervention an advantage over similar children not receiving the intervention. Remember that results from post-hoc test 2a suggested that children in the comparison group with high literacy interest did better than their peers in the same group. Despite this, children with the same high interest towards literacy in the treatment group did better on reading outcomes due to treatment than children in typical classrooms who themselves were responding to the typical classroom environment. Therefore, children with high interest towards literacy in the intervention had greater reading outcomes compared to their equally high interest peers in the comparison group, suggesting that the quality of the reading environment was important even for children already interested in literacy.

Keeping within literacy interest, low literacy interest was not enough alone to contribute to differences between the groups (post-hoc 3b). Upon examining Figure 1, what appears to be occurring (although not directly testable) is that low interest in the treatment group children results in them not necessarily receiving the same benefits in reading outcomes from the treatment as their high interest treatment peers. Having low interest in the comparison group does not seem to be as large of determinant, and therefore difference between the groups is small. In total, having high interest differentiates the two groups (and is more impactful for treatment children), but low interest does not differentiate the groups.

As stated, both literacy interest and effortful control did appear to be important when accounting for moderating reading outcomes between the intervention groups. In particular, we explored the literacy interest and effortful control of the children who appeared to be scoring the highest and lowest on reading, as these differences appeared to be the largest. It appears that high literacy interest and high effortful control is the best combination of behavior measured for a child to respond to literacy intervention. Figure 1 suggested that children in the treatment group with this behavioral profile did much better than similar children in the comparison group, and this difference was significant (post-hoc 3c). This result suggests that although this combination of beneficial behaviors would appear to help any child be successful in reading, these behaviors coupled with a successful intervention allowed some children to really bloom. Figure 1 also suggested that a group of children performed the lowest based on their behaviors. Specifically, children with low literacy interest and low effortful control in the comparison group scored lower on reading outcomes than children with similar poor profiles but in the treatment group. This interaction suggests that children in typical literacy classrooms with these low behaviors do not respond to typical instruction as well as their peers. This result also suggests that children in the intervention group with these poor behaviors are still able to score more highly on reading outcomes than their peers in typical instruction (although not as well as their peers in the intervention group), supporting the overall impact of the intervention.

Based on previous reports (e.g., Piasta et al., 2012), we know that the Project STAR intervention was successful in causing mean differences in kindergarten reading scores. The

present results suggest that individual differences in learning-related behaviors, especially high literacy interest and high effortful control, contributed to children successfully responding to the intervention project to produce high reading outcomes, possibly higher than their peers with other behaviors in the treatment group (even though as a group they had better reading outcomes than the comparison group). We propose that this is due to the intensive nature of the intervention, with preschool children having to sit and process the teacher-led interactive text reading. Although the overall intervention was impactful, some children, based on behaviors, did better than others within the treatment group.

These results have implications for literacy interventions in general, as children's behavioral profiles appear to influence their classroom reading outcomes. Intervention researchers should consider that learning-related individual differences, especially those not typically considered (such as closely related cognitive traits) can moderate the impact of instruction. Interestingly, the present intervention has been shown to be impactful for kindergarteners in this sample, even when not accounting for the interaction measured here (Piastra et al., 2012). The present results serve to suggest that even in an impactful intervention there are individual differences associated with reading outcomes due to intervention which are important to examine. We sought to explore new ways to consider child-by-instruction interactions in an intervention framework, and found that child learning-related behaviors not only interact with an intervention design, but also these behaviors are associated with how some children responded to treatment. This result doesn't mean that this intervention should only be given to some children based on their high literacy interest and high effortful control, as children on average in the treatment group indicated significant benefit. However, the knowledge that in general child learning-related behaviors, especially those outside of the typical preview of literacy interventions which tend to focus on related cognitive skills (e.g., language skills, general cognition), can influence response to treatment is important. We suggest approaching intervention work considering factors beyond initial, or closely related, cognitive skill. Indeed, greater outcomes due to treatment may have been shown in this project if efforts towards increasing interest towards literacy for all children were incorporated with the skill-based literacy intervention. There are a host of learning-related behaviors beyond the current two that may moderate response to intervention (e.g., student compliance to teacher requests, intellectual curiosity), and we encourage other researchers to consider the learning-related behaviors that might be important for their particular data.

There are limitations of this work to consider. This was an exploratory study involving secondary data analysis using a project which was not intended to examine individual differences moderators of response to intervention. Therefore, the measures, especially the questions involving interest in literacy, were not ideal. Additionally, there are likely many other measures of learning-related behaviors that may have also been moderators of the response to intervention that could not be included because they were not available. Finally, given the relatively low correlation of the learning-related behaviors with the reading outcomes, it may be the case that other correlates not included here are more important moderators. We caution the readers that we intend for this work to simply be representative of an idea that there may be individual differences in which children respond to intervention based on characteristics that are not closely related to the actual intervention.

Previous work has suggested that child individual differences can interact with outcomes associated with classroom instruction (e.g., Connor et al., 2004) and by extension educational interventions. However this work has typically focused on close cognitive correlates. The area broadly defined as learning-related behaviors may be ideal to target during literacy interventions. Moreover, this work suggests these behavioral sources of individual differences may play a role in how children respond to intervention. We encourage future work to explore if these learning-related behaviors give evidence for greater intervention outcomes than implied by more typical aggregate results, for both successful and unsuccessful interventions. This can help intervention researchers to more holistically focus on individualizing literacy intervention, which could lead to greater gains for more children.

## Acknowledgements

We are grateful to the many administrators, teachers, children, and families who contributed to this project. Members of our research team requiring special mention include Xitao Fan, Amy Sofka, Aileen Hunt, Elizabeth Cottone, Tricia Zucker, and Jill Pentimonti, among others. Funding for Project STAR was provided by the U.S. Department of Education, Institute of Education Sciences, Grant R305G050057. The content of this publication does not necessarily reflect the views or policies of the Institute of Education Sciences, nor does mention of trade names, commercial products, or organizations imply endorsement by the U.S. Department of Education.

The conceptualization of this paper led in part to NICHD grant HD072286, which subsequently supported [blinded for review] time in writing the manuscript. Views expressed herein are those of the authors and have neither been reviewed nor approved by the granting agencies.

## References

- Aiken, L.S., West, S. Multiple regression: Testing and interpreting interactions. Sage Publications, Inc.; Thousand Oaks, CA: 1991.
- Al Otaiba S, Fuchs D. Characteristics of children who are unresponsive to early literacy intervention. *Remedial and Special Education*. 2002; 23(5):300–316.
- Belsky J, Pluess M. Beyond diathesis stress: differential susceptibility to environmental influences. *Psychological bulletin*. 2009; 135(6):885. [PubMed: 19883141]
- Blair C, Razza RP. Relating effortful control, executive function, and false belief understanding to emerging math and literacy ability in kindergarten. *Child Development*. 2007; 78(2):647–663. [PubMed: 17381795]
- Caspi O, Bell IR. One size does not fit all: Aptitude x treatment interaction (ATI) as a conceptual framework for complementary and alternative medicine outcome research. Part II-Research designs and their applications. *Journal of Alternative & Complementary Medicine*. 2004; 10(4):698–705. [PubMed: 15353030]
- Cole KN, Dale PS. Direct language instruction and interactive language instruction with language delayed preschool children: A comparison study. *Journal of Speech, Language and Hearing Research*. 1986; 29(2):206–217.
- Connor CM, Morrison FJ, Katch LE. Beyond the reading wars: Exploring the effect of child-instruction interactions on growth in early reading. *Scientific Studies of Reading*. 2004; 8(4):305–336.
- Connor CM, Piasta SB, Fishman B, Glasney S, Schatschneider C, Crowe E, Morrison FJ. Individualizing student instruction precisely: Effects of child by instruction interactions on first graders' literacy development. *Child Development*. 2009; 80(1):77–100. [PubMed: 19236394]
- Connor CM, Son SH, Hindman AH, Morrison FJ. Teacher qualifications, classroom practices, family characteristics, and preschool experience: Complex effects on first graders' vocabulary and early reading outcomes. *Journal of School Psychology*. 2005; 43(4):343–375.



- Crain-Thoreson C, Dale PS. Do early talkers become early readers? Linguistic precocity, preschool language, and emergent literacy. *Developmental Psychology*. 1992; 28(3):421–429.
- Deater-Deckard K, Mullineaux PY, Petrill SA, Thompson LA. Effortful control, Surgency, and reading skills in middle childhood. *Reading and Writing*. 2009; 22(1):107–116. [PubMed: 20526377]
- Deault L, Savage R, Abrami P. Inattention and response to the ABRACADABRA web-based literacy intervention. *Journal of Research on Educational Effectiveness*. 2009; 2(3):250–286.
- Fletcher JM, Stuebing KK, Barth AE, Denton CA, Cirino PT, Francis DJ, Vaughn S. Cognitive Correlates of Inadequate Response to Reading Intervention. *School Psychology Review*. 2011; 40(1):3–22. [PubMed: 23125475]
- Frijters JC, Barron RW, Brunello M. Direct and mediated influences of home literacy and literacy interest on prereaders' oral vocabulary and early written language skill. *Journal of Educational Psychology*. 2000; 92(3):466–477.
- Guthrie JT, Wigfield A. How motivation fits into a science of reading. *Scientific Studies of Reading*. 1999; 3(3):199–205.
- Guthrie JT, Wigfield A, VonSecker C. Effects of integrated instruction on motivation and strategy use in reading. *Journal of Educational Psychology*. 2000; 92(2):331–341.
- Hidi S. Interest and its contribution as a mental resource for learning. *Review of Educational Research*. 1990; 60(4):549–571.
- Jaccard, J., Turrisi, R. Interaction effects in multiple regression. Sage; Newbury Park: 2003.
- Justice LM, Ezell HK. Enhancing children's print and word awareness through home-based parent intervention. *American Journal of Speech-Language Pathology*. 2000; 9(3):257–269.
- Justice LM, Ezell HK. Use of storybook reading to increase print awareness in at-risk children. *American Journal of Speech-Language Pathology*. 2002; 11(1):17–29.
- Justice LM, Kaderavek JN, Fan X, Sofka A, Hunt A. Accelerating preschoolers' early literacy development through classroom-based teacher-child storybook reading and explicit print referencing. *Language, Speech, and Hearing Services in Schools*. 2009; 40(1):67–85.
- Justice LM, McGinty AS, Piasta SB, Kaderavek JN, Fan X. Print-Focused Read-Alouds in Preschool Classrooms: Intervention Effectiveness and Moderators of Child Outcomes. *Language, Speech, and Hearing Services in Schools*. 2010; 41(4):504–520.
- Justice, LM., Sofka, A. Engaging children with print: Building early literacy skills through quality read-alouds. Guilford Press; New York, NY: 2010.
- Kanfer R, Ackerman PL. Motivation and cognitive abilities: An integrative/aptitude-treatment interaction approach to skill acquisition. *Journal of Applied Psychology*. 1989; 74(4):657–690.
- Keogh, BK. Temperament in the classroom: Understanding individual differences. Brookes; Baltimore, MD: 2003.
- Ladd GW, Birch SH, Buhs ES. Children's social and scholastic lives in kindergarten: Related spheres of influence? *Child Development*. 1999; 70(6):1373–1400. [PubMed: 10621962]
- Lewit EM, Baker LS. School readiness. *The Future of Children*. 1995:128–139. [PubMed: 8528685]
- Liew J, McTigue EM, Barrois L, Hughes JN. Adaptive and effortful control and academic self-efficacy beliefs on achievement: A longitudinal study of 1st through 3rd graders. *Early Childhood Research Quarterly*. 2008; 23(4):515–526. [PubMed: 19169387]
- Lovelace S, Stewart SR. Increasing print awareness in preschoolers with language impairment using non-evocative print referencing. *Language, Speech, and Hearing Services in Schools*. 2007; 38(1): 16–30.
- Lyon GR, Shaywitz SE, Shaywitz BA. A definition of dyslexia. *Annals of Dyslexia*. 2003; 53(1):1–14.
- McGinty AS, Breit-Smith A, Fan X, Justice LM, Kaderavek JN. Does intensity matter? Preschoolers' print knowledge development within a classroom-based intervention. *Early Childhood Research Quarterly*. 2011; 26(3):255–267.
- McGinty AS, Justice LM, Piasta SB, Kaderavek J, Fan X. Does context matter? Explicit print instruction during reading varies in its influence by child and classroom factors. *Early Childhood Research Quarterly*. 2012; 27(1):77–89.
- National Assessment of Education Progress. The nation's report card. National Center for Education Statistics; Washington, DC: 2005.

- NICHD Early Child Care Research Network. Do children's attention processes mediate the link between family predictors and school readiness? *Developmental Psychology*. 2003; 39:581–593.
- NICHD Early Child Care Research Network. Multiple pathways to early academic achievement. *Harvard Educational Review*. 2004; 74:1–29.
- Peterson PL, Janicki TC. Individual characteristics and children's learning in large-group and small-group approaches. *Journal of Educational Psychology*. 1979; 71(5):677–687.
- Piasta SB, Connor CM, Fishman B, Morrison FJ. Teachers' knowledge of literacy, classroom practices, and student reading growth. *Scientific Studies of Reading*. 2009; 13:224–228.
- Piasta SB, Dynia JM, Justice LM, Pentimonti JM, Kaderavek JN, Schatschneider C. Impact of professional development on preschool teachers' print references during shared read alouds: A latent growth curve analysis. *Journal of Research on Educational Effectiveness*. 2010; 3(4):343–380.
- Piasta SB, Justice LM, McGinty AS, Kaderavek JN. Increasing young children's contact with print during shared reading: Longitudinal effects on literacy achievement. *Child Development*. 2012; 83(3):810–820. [PubMed: 22506889]
- Posner, MI., Rothbart, MK. *Educating the human brain*. American Psychological Association; Washington, DC: 2006.
- Putnam SP, Rothbart MK. Development of short and very short forms of the Children's Behavior Questionnaire. *Journal of Personality Assessment*. 2006; 87(1):102–112. [PubMed: 16856791]
- Raudenbush, SW., Bryk, AS. *Hierarchical linear models: Applications and data analysis methods*. Vol. 1. Sage Publications, Inc.; 2002.
- Rutter M, Maughan B. School effectiveness findings 1979-2002. *Journal of School Psychology*. 2002; 40(6):451–475.
- Schiefele U, Csikszentmihalyi M. Interest and the quality of experience in classrooms. *European Journal of Psychology of Education*. 1994; 9(3):251–270.
- Sénéchal M, LeFevre JA, Hudson E, Lawson EP. Knowledge of storybooks as a predictor of young children's vocabulary. *Journal of Educational Psychology*. 1996; 88(3):520–536.
- Shadish, WR., Cook, TD., Campbell, DT. *Experimental and quasi-experimental designs for generalized causal influence*. Houghton Mifflin Company; Boston: 2002.
- Snow RE. Aptitude-treatment interaction as a framework for research on individual differences in psychotherapy. *Journal of Consulting and Clinical Psychology*. 1991; 59(2):205. [PubMed: 2030178]
- Snow R. Aptitude theory: Yesterday, today, and tomorrow. *Educational Psychologist*. 1992; 27(1):5–32.
- Sparks A, Reese E. From reminiscing to reading: Home contributions to children's developing language and literacy in low-income families. *First Language*. 2013; 33(1):89–109.
- Speece DL. Aptitude-Treatment Interactions Bad Rap or Bad Idea? *The Journal of Special Education*. 1990; 24(2):139–149.
- Stipek D, Newton S, Chudgar A. Learning-related behaviors and literacy achievement in elementary school-aged children. *Early Childhood Research Quarterly*. 2010; 25(3):385–395.
- Valiente C, Lemery-Chalfant K, Castro KS. Children's effortful control and Academic Competence: Mediation through School Liking. *Merrill Palmer Quarterly*. 2007; 53(1):1.
- Valiente C, Lemery-Chalfant K, Swanson J. Prediction of kindergartners' academic achievement from their effortful control and emotionality: Evidence for direct and moderated relations. *Journal of Educational Psychology*. 2010; 102(3):550–560.
- Valiente C, Lemery-Chalfant K, Swanson J, Reiser M. Prediction of children's academic competence from their effortful control, relationships, and classroom participation. *Journal of Educational Psychology*. 2008; 100(1):67–77. [PubMed: 21212831]
- Vellutino FR, Scanlon DM, Sipay ER, Small SG, Pratt A, Chen R, Denckla MB. Cognitive profiles of difficult-to-remediate and readily remediated poor readers: Early intervention as a vehicle for distinguishing between cognitive and experiential deficits as basic causes of specific reading disability. *Journal of Educational Psychology*. 1996; 88(4):601–638.

- Vellutino FR, Scanlon DM, Zhang H, Schatschneider C. Using response to kindergarten and first grade intervention to identify children at-risk for long-term reading difficulties. *Reading and Writing*. 2008; 21(4):437–480.
- Wigfield, A. Children's motivations for reading. In: Malloy, JA. Marinak, BA., Gambrell, LB., editors. *Essential Readings on Motivation*. International Reading Association; New York: 2010. p. 13-27.
- Woodcock, R., McGrew, KS., Mather, N. *Woodcock-Johnson Tests of Achievement*. 3rd ed. Riverside; Itasca, IL: 2001.

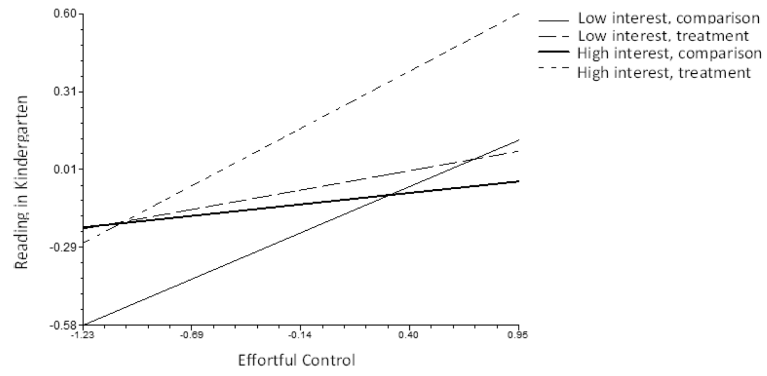
Author Manuscript

Author Manuscript

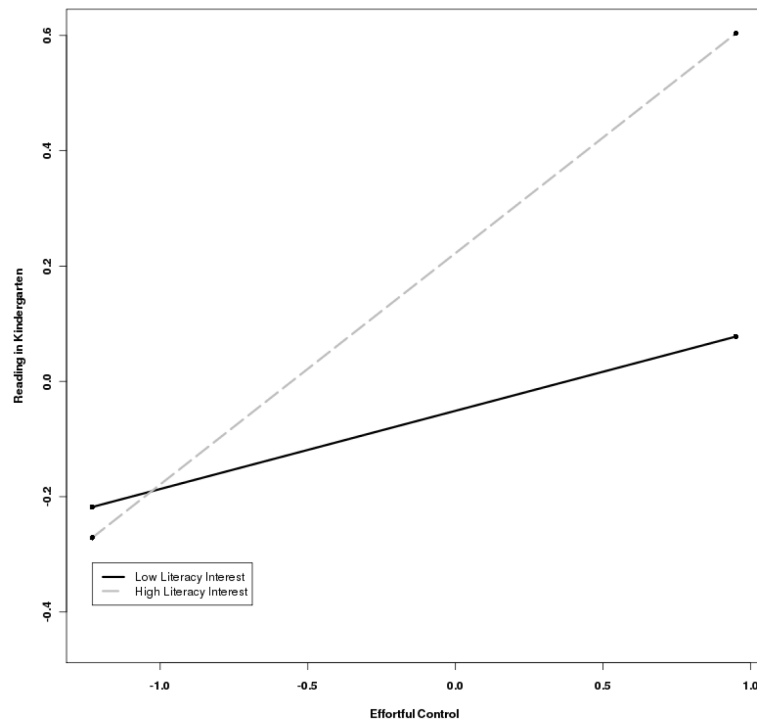
Author Manuscript

Author Manuscript

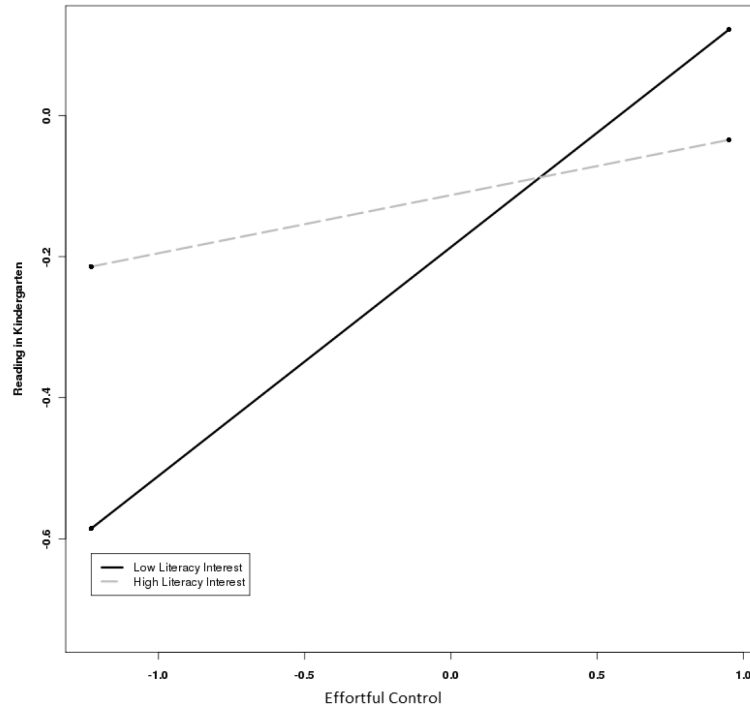
- Individual characteristics of a child can interact with instruction
- These characteristics can affect the success of educational interventions
- Interest in literacy and effortful control were examined as moderators of intervention
- Children with high interest in literacy and effortful control showed greatest gains due to intervention
- Accounting for a greater breadth of possible moderators of intervention impacts is an important



**Figure 1.** Full three-way interaction model among literacy interest, effortful control, and intervention status.



**Figure 2.** Three-way interaction among literacy interest, effortful control, and intervention status, in treatment group only.



**Figure 3.** Three-way interaction among literacy interest, effortful control, and intervention status, in comparison group only.

**Table 1**

Descriptive information for participating children

	Study Group		
	Treatment Group (n=216)	Comparison Group (n=98)	Total (n=314)
Age in months			
<i>M</i>	53.45	53.53	53.47
<i>SD</i>	3.55	3.50	3.53
% female	50.00	46.90	49.00
% speaking English at home	95.40	95.90	95.50
Race-ethnicity			
% White, non-Hispanic	40.30	48.00	42.70
% African American/Black	41.70	35.70	39.80
% Hispanic-Latino	6.00	5.10	5.70
% Multiracial	9.30	9.20	9.20
% Other	2.70	2.00	2.60
Maternal education (highest degree attained)			
% no high school diploma	14.40	25.50	17.80
% high school diploma	18.10	24.50	20.10
% high school diploma plus some college or technical training	44.90	27.60	39.40
% associate's degree	8.30	12.20	9.60
% bachelor's degree	8.30	6.10	7.60
% graduate degree	1.90	2.00	1.90
Family income			
% \$0 to \$15,000	30.60	37.70	32.50
% \$15,001 to \$30,000	28.20	22.20	26.50
% \$30,001 to \$45,000	15.70	16.40	15.90
% \$45,001 to \$60,000	7.90	11.20	8.90
% > \$60,000	10.20	7.30	7.90

*Note.* Percentages may not sum to 100% due to rounding or missing data.



**Table 2**  
Descriptive statistics for reading, literacy interest, and effortful control measures

Measure	Treatment Group (n=216)			Comparison Group (n=98)			Total (n=314)		
	Mean	SD	Range	Mean	SD	Range	Mean	SD	Range
WRMT Passage Comprehension <sup>a</sup>	8.60	3.93	2-29	7.99	2.75	3-15	8.41	3.61	2-29
WRMT Reading Fluency <sup>a</sup>	1.75	5.30	0-38	.11	.55	0-4	1.24	4.47	0-38
WMRT Letter-Word Identification <sup>a</sup>	20.83	6.55	3-56	19.07	4.59	5-34	20.28	6.05	3-56
How many times did your child ask to be read to last week?	3.24	2.34	0-8	3.38	2.34	0-8	3.35	2.35	0-8
How many times did your child look at books on his/her own last week?	4.86	2.33	0-8	4.77	2.16	0-8	4.82	2.28	0-8
How much do you think your child enjoys being read to?	4.31	0.86	1-5	4.37	.87	1-5	4.33	.86	1-5
effortful control <sup>b</sup>	5.15	0.90	1.67-7.00	5.13	.77	3.36-6.67	5.15	.86	1.67-7.00

*Note.* Descriptive statistics are listed for each reading measure individually for sample comparison purposes, but in analyses the three reading measures were combined into a single factor score which was used as the main outcome variable (see Method). Reading was measured in Kindergarten, one year post-intervention. Literacy interest and effortful control were measured in preschool, the intervention year.

<sup>a</sup>Woodcock-Johnson Tests of Achievement III

<sup>b</sup>Child Behavior Questionnaire-Very Short Form

**Table 3**

Results of hierarchical linear modeling predicting reading, with all interactions tested.

	Coefficient	SE	t	df	p
Fixed effect					
Intercept	-.15	.05	-3.11	73	.003
Literacy interest	.06	.08	.69	233	.490
Effortful control	.21	.06	3.43	233	.000
Intervention status	.23	.09	2.38	73	.020
Effortful control*literacy interest	-.18	.10	-1.94	233	.054
Effortful control*Intervention status	.05	.10	.51	233	.614
Literacy interest*Intervention status	.15	.11	1.33	233	.184
Effortful control* literacy interest*Intervention status	.39	.14	2.76	233	.006
Random effect					
Teacher level	.10	2.32	.010		
Child level	.71	11.21	.000		
Variance		z-test	p		

Note.  $n = 314$ , reflecting only children with complete data who were included in the analysis.

**Table 4**  
Results of *post-hoc* contrast tests of the three-way interaction model as displayed in Table 3.

Post-hoc contrasts	Coefficient	SE	t	df	p
<i>Research Question 1. Within treatment group</i>					
1a High literacy interest, effect of effortful control	0.43	0.13	3.31	233	.001
1b Low literacy interest, effect of effortful control	0.09	0.10	0.88	233	.382
<i>Research Question 2. Within comparison group</i>					
2a High literacy interest, effect of effortful control	0.05	0.13	0.40	233	.687
2b Low literacy interest, effect of effortful control	0.37	0.06	5.81	233	.000
<i>Research Question 3. Between intervention groups</i>					
3a High literacy interest	-0.36	0.16	-2.20	73	.031
3b Low literacy interest	-0.10	0.10	-0.94	73	.352
3c High literacy interest, high effortful control	-0.69	0.25	-2.75	73	.008
3d Low literacy interest, low effortful control	-0.34	0.13	-2.65	73	.010

*Note.*  $n = 314$ , reflecting only children with complete data who were included in the analysis.