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**Title:** From BookStart to BookSmart: about the importance of an early start with parent-child reading

**Issue Date:** 2015-05-19

# Chapter

# 3

## **Beneficial Effects of BookStart in Temperamentally Highly Reactive Infants**

## Abstract

At the birth of their child, parents living in areas where BookStart has been adopted receive a package containing a baby book, a CD, and a flyer about book sharing. In this study we tested whether this extensive, nation-wide intervention is a stimulus for language development. Three hundred and fifty-nine 'BookStart families' were compared with 225 control families. Assessments took place when the infant was 8 months old, and 7 months later. The overall effects of BookStart on language development at 15 months were small ( $d = 0.05$ ) but moderately high ( $d = .46$ ) in a sub-sample of temperamentally highly reactive children (25% of the sample). Findings were in line with the differential susceptibility model. A reactive temperament proved a risk factor for language development, due to low verbal stimulation from parents in the first years, but an asset when parents increased verbal parent-child interaction under the influence of BookStart.

*Based on:*

Van den Berg, H., & Bus, A. G. (2014). Beneficial effects of BookStart in temperamentally highly reactive infants. *Learning and Individual Differences*, 36, 69-75. doi: 10.1016/j.lindif.2014.10.008

In the current study we tested effects of BookStart – a program first started in Great Britain and later adopted in other European countries and Australia, Canada, Colombia, Jamaica, Japan, Korea, New Zealand, and Thailand (e.g., Hall, 2001; Hardman & Jones, 1999; Wade & Moore, 1998). BookStart was first implemented in the south of the Netherlands in 2009, and has since then spread throughout the country. Parents of new-born babies living in areas where BookStart has been adopted receive a voucher from the local government for a baby book, a CD with children's songs, and a flyer explaining the importance of an early start with shared book reading. The package also includes free membership for the baby of a local library equipped with a rich collection of baby books. Librarians are trained to advise parents and organize workshops about how to involve infants in book sharing, singing songs, telling stories, or reciting rhymes.

Is participating in BookStart beneficial for young children's language development, and what are the changes in activities that promote language development? Investigations into BookStart show positive effects on frequency of parent-child language activities (e.g., Wade & Moore, 1996), parental attitude towards sharing books with babies (Vanobbergen, Daems, & Tilburg, 2009), and language and literacy scores at the start of primary education according to the Birmingham Baseline Assessment (Wade & Moore, 1998). By comparing children from families who had collected the BookStart package at the library ( $n = 359$ ) with children from similar families who were born in areas where BookStart had not yet been adopted ( $n = 225$ ) we tested whether parents create a positive language environment under the influence of BookStart. We inquired about a broad range of verbal activities encompassing passive exposure to language such as television or computer as well as activities that include parent-child interaction. We expected that improvements in language resulting from BookStart are mediated in particular by verbal activities involving parent-child interaction, such as shared book reading or storytelling (e.g., Bus, 2001; Duursma, Augustyn, & Zuckerman, 2008). In a recent study, Ramírez-Esparza, García-Sierra, and Kuhl (2014) demonstrated, by means of the Language Environment Analysis device, that it is especially the quality of parent-child one-to-one interaction that promotes language development, rather than the quantity of words the child is exposed to during other activities.

To obtain an insight into which home activities are promoted by BookStart and mediate effects on language development, we asked parents to complete a questionnaire at two assessments, including questions about a range of their baby's verbal activities: book sharing, watching television, singing songs, listening to music, reciting rhymes, storytelling, playing with apps on digital devices, and other verbal

activities. To test which activities in particular may be linked to effects of BookStart we used mediation analysis (Baron & Kenny, 1986; MacKinnon, Fairchild, & Fritz, 2007; Preacher & Hayes, 2008).

### **Differential effects of BookStart**

Backed up by a wealth of studies (e.g., Bus, 2001; DeBaryshe, 1995; Duursma et al., 2008; Hart & Risley, 2003; Sénéchal, 2000), most parents in Western countries are aware of the need for verbal interaction from an early stage to stimulate their infants' language. A minority of parents may nevertheless be less motivated to interact verbally with their child in the first years, due to their infants' negative responses. Children with a highly reactive temperament may typically respond negatively to verbal interactions as a result of their proneness to sadness, anger, and frustration. Because interactions are less rewarding and often frustrating, their parents may initiate verbal interactions less frequently than parents of temperamentally less reactive infants (e.g., Dixon & Smith, 2000; Karrass, VanDeventer, Mullins, & Lefever, 2002). We examined whether BookStart may be especially effective for temperamentally highly reactive children. By emphasizing the need for verbal interaction with infants despite the children's responses, BookStart may prevent parents from stopping interactions if the child reacts negatively.

As a result of negative interactions with their child, parents have been found to develop negative feelings about their parenting skills, and may, as a result, stop making regular attempts to involve their child in verbal interactions (e.g., Banerjee & Tamis-LeMonda, 2007; Machida, Taylor, & Kim, 2002; Usai, Garello, & Viterbori, 2009). Fathers, for instance, read less frequently to their children when they are temperamentally highly reactive (Karrass, VanDeventer, & Braungart-Rieker, 2003). Likewise, mothers of children who show negative distress speak less to their children and use less complex utterances than mothers of less distressed children (Machida et al., 2002; Vernon-Feagans et al., 2008). As appears from several studies on the effects of children's temperament on language development, highly reactive children are at risk for language delays (e.g., Dixon & Smith, 2000; Karrass et al., 2002; Usai et al., 2009). Infants who show negative affective behaviors (i.e., crying, hitting, throwing, withdrawing, and fearfulness) are found to lag behind on short- and long-term tests of language proficiency (Caulfield, Fischel, DeBaryshe, & Whitehurst, 1989; Laake et al., 2013; Paul & Kellogg, 1997; Slomkowski, Nelson, Dunn, & Plomin, 1992), in cognitive development (Fagen, Singer, Ohr, & Fleckenstein, 1987), and in their acquisition of reading precursors (Newman, Noel, Chen, & Matsopoulos, 1998).

In sum, it is especially children with a highly reactive temperament who may be at risk for delays in language development. When parents persist in reading to their highly reactive infant, under influence of BookStart their child may reach the same score on language skills as less reactive peers (Zuckerman, 1999). Thus, the interaction between temperament and intervention may take the form of the classical diathesis-stress model: groups differ without intervention but are alike when the environment offers extra stimuli (Belsky, Bakermans-Kranenburg, & Van IJzendoorn, 2007). In other words, the interaction shows either an *ordinal* form without crossover point, or a crossover point near the extremes (Widaman et al., 2012).

### **Diathesis-stress versus differential susceptibility**

There is some exciting new evidence in the literature for an alternative model of interactions between child characteristics and environmental factors, called differential susceptibility (Belsky et al., 2007). Unlike the diathesis-stress model, high reactivity is not just a risk for learning but a challenge as well (Belsky & Pluess, 2009). Under suboptimal conditions, more susceptible children lag behind their peers, but they actually outperform peers lacking the putative ‘vulnerable’ constitution under optimized learning conditions. If this model applies to infants showing a highly reactive temperament (Blair, 2002; Poehlmann et al., 2012; Widaman et al., 2012), we may expect a *disordinal* BookStart-by-temperamental interaction: without BookStart, children with a highly reactive temperament lag behind their peers, but if a highly reactive temperament helps to improve learning, infants in an optimal environment (here: BookStart) outperform their peers.

So far, only few experiments with early literacy interventions (e.g., Kegel, Bus, & Van IJzendoorn, 2011; Van der Kooy-Hofland, Van der Kooy, Bus, Van IJzendoorn, & Bonsel, 2012) tested differential susceptibility in the cognitive domain. In our study, we took into account the double-edged nature of temperamental reactivity – serving as a risk factor for academic skills under suboptimal conditions but as a potential asset under optimal conditions – as a possible outcome. If a highly reactive temperament actually implies high susceptibility to environmental factors, we may expect that, without BookStart, these infants lag behind in language development at 15 months, but outperform their temperamentally less reactive peers if parents participate in BookStart and create better learning conditions.

### **This study**

In sum, the aim of our study was threefold: (1) testing whether BookStart affects language development, and which activities in particular mediate effects of BookStart

on language development, (2) testing whether BookStart is especially effective if children have a negative temperament and parents are less inclined to initiate verbal interactions with their infant, and (3) testing whether children with a highly reactive temperament are more susceptible to the environment; we expect that they lag behind their peers without intervention but outperform other children with BookStart.

## Methods

### Participants

The 'BookStart parents' came from eight provinces in the Netherlands, so covering most of the country. Only those parents who collected the BookStart materials at the library were invited to participate. The control group was recruited through 35 child health centers in comparable areas, where BookStart had not yet been introduced. The staff of the centers handed out invitation letters to parents of babies in the correct age range (control group). In both samples, all education levels were represented except for the lowest educated parents (primary or special education): Their number did not exceed 1% of the total sample, whereas this percentage is 8.29% for the Dutch population as a whole (*Centraal Bureau voor de Statistiek* [Statistics Netherlands], 2010). The low participation of the lowest educated families may be explained by the fact that the data were collected via a questionnaire. The BookStart and control groups did not differ in percentage of low-educated parents (i.e., no high school education for either one or both parents in the family),  $\chi^2(1) = 1.76, p = .19$ . The primary caregiver of the child (in 95% of the cases the mother) completed a questionnaire twice, the first time between March and December 2011 when the youngest child was on average 8 months ( $M = 8.15, SD = 1.42$ ), and again about 7 months later when the target child was on average 15 months ( $M = 15.36, SD = 1.47$ ). Participants were included when (a) they had completed the questionnaire at 8 and at 15 months, (b) all questions about background variables had been filled in, and (c) Dutch was the first or second language at home. Seventy-five percent of those who completed the questionnaire at 8 months ( $N = 782$ ) filled in the second questionnaire as well ( $N = 584$ ). Two parents were excluded because Dutch was not their first or second home language. Descriptive statistics for the BookStart and comparison groups are presented in Table 1. The families that we lost ( $N = 198$ ) were similar to the families that completed both questionnaires regarding temperamental reactivity and background variables such as gender and age; the only difference was education level, which was lower in the families that dropped out ( $t(780) = -2.855, p < .05$ ).

### BookStart program

The BookStart parents in this study had collected the package free of charge at the local library, including a baby book, a CD with children's songs, and a flyer explaining the relevance of sharing books with babies. These parents also received free library membership for their baby, which enabled them to borrow baby books and receive advice from librarians about books, shared reading, and language and literacy-related activities such as reciting rhymes, storytelling, and singing songs. Parents also received invitations for workshops, which they rarely accepted.

**Table 1** Descriptives of the BookStart and Control group ( $N = 584$ )

	BookStart ( $n = 359$ )	Control ( $n = 225$ )
Boys (%)	52%	49%
Age in Months (T1)	8.12 (1.46)	8.20 (1.30)
Age in Months (T2)	15.30 (1.52)	15.45 (1.38)
Time between T1 and T2 in months	7.18 (.47)	7.25 (.50)
Education level of parents <sup>1</sup>	4.35 (1.29)	4.10 (1.30)
Temperamental reactivity (factor score)	-.03 (1.03)	-.09 (.96)
CDI/expressive	9.63 (9.04)	10.43 (8.53)
CDI/receptive	30.78 (13.63)	32.03 (13.34)
Composite language measure ( $z$ -score)	.00 (.87)	.00 (.88)

Note. T1=first questionnaire; T2=second questionnaire; MacArthur-Bates CDI

<sup>1</sup> Scale ranged from 0 (no level of education for both parents) to 6 (both parents received university degree)

### Procedure

At the first assessment, when children were on average eight months old, parents received an invitation letter or email from the child health center or the library asking them to fill in a questionnaire about the home literacy environment and the child's temperament. Completion took about 20 minutes. About seven months later the researcher invited the parents by email or regular mail to complete a similar questionnaire about the home activities and language development of their child. At both assessments, parents had the choice between a paper version of the questionnaire or an internet version. Parents received a small present (i.e., a baby calendar) after completing both questionnaires.

### Measures

The first assessment (at about 8 months) included about 40 items assessing background information (including education level, home language, and child's gender and age),



home literacy activities (i.e., frequency of book sharing, telling stories, watching television, and listening to music), and the Infant Behavior Questionnaire. The second assessment (at about 15 months) included the same questions about home literacy activities as the first assessment, but was expanded with the MacArthur-Bates Communicative Development Inventory (MacArthur-Bates CDI) to measure language development.

**Background information.** Parents indicated their highest educational level: primary education (normal or special), lower secondary vocational education, higher secondary education, higher vocational education, college, pre-university/university. The scale ranged from 0 (no level of education for both parents) to 6 (both parents received a university degree). Parents reported the target child's gender, and first and second home languages.

**Home literacy environment.** This part included questions about verbal home activities: How often do you involve your child in shared reading, singing songs, storytelling, rhyming, watching television, playing with internet applications, and listening to baby music? Parents answered these seven questions on a 4-point scale (daily, once or twice a week, once a month, (almost) never).

**Infant Behavior Questionnaire.** To assess temperament, we included 22 items of a Dutch version of the Infant Behavior Questionnaire - revised (IBQ-r), with high loadings on the 'smile and laughter' and 'activity' scales (Gartstein & Rothbart, 2003). The items were translated from English into Dutch by M. Roest-de Zeeuw and K. van Doesum and validated in a Dutch study (Klein-Velderman, Bakermans-Kranenburg, & Juffer, 2006). Parents completed 22 items describing child behavior in parent-child interaction (e.g., smiling, fussing, crying) on an 8-point scale (ranging from 'always' to 'not applicable').

**MacArthur-Bates CDI.** A Dutch adaptation (Zink & Lejaegere, 2003) of the shortened MacArthur-Bates Communicative Development Inventory (Fenson et al., 2000) was used to examine the language development of infants in their second year. On a list containing 55 words parents were asked to indicate which ones their child could produce and / or comprehend. The list included words such as *poes* [cat], *boek* [book], *deur* [door], and *bloem* [flower]. The composite score, based on the receptive ( $\alpha = .95$ ) and expressive scales ( $\alpha = .93$ ), was a moderately strong predictor of a Dutch adaptation of the Reynell Developmental Language Scales for the age range of two to seven years ( $r = .405, p < .001$ ; Schlichting, Van Eldik, Spelberg, Van der Meulen, & Van der Meulen, 1995). We applied the Reynell Developmental Language Scales during home visits in a subsample of sixty-three randomly selected children one year after completion of MacArthur-Bates CDI.

## Analyses

**Testing interactions.** A main aim was to test whether temperament moderates effects of BookStart and whether interactions, if present, are consistent with differential susceptibility. Therefore we regressed language skills on BookStart and temperament. In a first step, control variables were entered (age in months, gender, and education level); in the second, temperamental reactivity and condition (BookStart vs. control); and in the third, temperamental reactivity x condition. The predictor ‘temperamental reactivity’ was mean-centered (Aiken & West, 1991). Post hoc simple regressions were performed to determine the steepness of the slopes per condition (Cohen, Cohen, West, & Aiken, 2003). Using the point estimate of the crossover point and its confidence interval, we tested whether a BookStart-by-temperament interaction, if present, was ordinal or disordinal, following Widaman’s procedure (Widaman et al., 2012).

**Testing mediation.** An effective way of examining home activities that cause effects of BookStart is provided by mediation analysis (Baron & Kenny, 1986; MacKinnon et al., 2007; Preacher & Hayes, 2008). For testing a mediation model we preferred the *bootstrapping* approach as described by Preacher and Hayes (2008) over the *causal steps* approach of Baron and Kenny (1986). The bootstrapping approach is a way to test if the indirect effect of the independent variable on the dependent variable is significant: (a) the independent variable (BookStart) relates to the mediator (home activities); and (b) the mediator (home activities) relates to the dependent variable (language skills). Unlike the causal steps approach, in the bootstrap approach the predictor is not necessarily related directly to the outcome variable (Preacher & Hayes, 2008). In a (multiple) mediation model one mediator can suppress the effects of other mediators and affect the direct relation between predictor and outcome variables (MacKinnon, Krull, & Lockwood, 2000). By using a resampling method, the bootstrap procedure can yield percentile confidence intervals of the total effect of indirect effects, which proved a basis to test whether mediator variables add significantly to the model and mediate the effect of independent variables on outcomes. The bootstrap mediation procedure makes it possible to include two or more mediators controlling for the influence of three covariates: age (in months), education level, and gender.

## Results

### Infant temperament

A PCA applied to all items of the Infant Behavior Questionnaire revealed the factors ‘temperamental reactivity’ and ‘activity level’, explaining 17.29% (eigenvalue= 3.80)

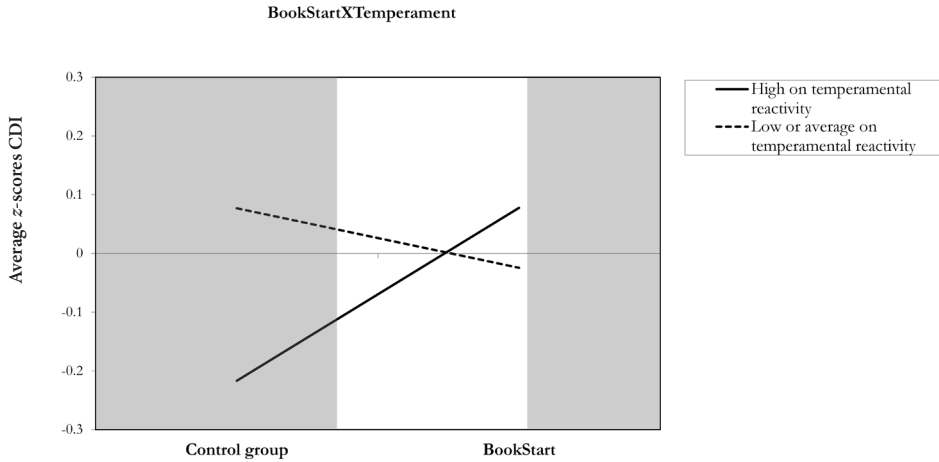


Figure 1. Predicted language scores at 15 months for children high in temperamental reactivity and average or low in temperamental reactivity controlling for influence of age in months, gender, and education level. Striped line: 75% children scoring low to average on temperamental reactivity (IBQ); dark line: 25% scoring highest on temperamental reactivity. Grey shaded areas indicate confidence intervals (CI) around the crossover point ( $\hat{C}$ ).

**Table 2** Effects of BookStart in the total group and the subsample of children with the 25% highest score on temperamental reactivity on language skills, controlling for age, gender, and education level

	<i>n</i>	Estimate (SE)	95% CI <i>B</i>	<i>T</i>	<i>p</i>	Cohen's <i>d</i> <sup>3</sup>
Total group	584	.04 (.07)	-.09 - .17	.64 <sup>1</sup>	.53	.05
Subsample high on temperamental reactivity (25%)	144	.37 (.14)	.10 - .64	2.72 <sup>2</sup>	.007	.46
Subsample low on temperamental reactivity (75%)	440	-.07(.07)	-.21 - .07	-.97	.33	-.09

Note. CI = Confidence Interval. <sup>1</sup> *df* = 581. <sup>2</sup> *df* = 141. <sup>3</sup> For calculating Cohen's *d* Thalheimer and Cook's (2002) formula was used:  $2t/\sqrt{(n - 2)}$ .

and 11.92% of the variance (eigenvalue= 2.62), respectively. In this study we focused on the first factor that strongly overlapped with Rothbart's 'smile and laughter' scale, an indicator for 'temperamental reactivity' (Gartstein & Rothbart, 2003; Rothbart, 1981). The six items with high loadings on this scale are linked to emotions during lying on the back and bath-, dress-, play-, and face/hair wash activities. The temperamental reactivity scale was recoded so that higher scores indicated higher temperamental reactivity. These infants showed less positive and more negative emotions when lying on their backs and during bath-, dress-, play-, and face/hair wash activities. Loadings of the six items ranged from .56 for showing emotional reactivity during play, to .75 for showing emotional reactivity during hair washing. Alpha reliability equaled .74. Descriptive statistics are shown in Table 1.

**Interaction BookStart-by-temperament.** Our main analysis focused on the language scores when children averaged 15 months, and the extent to which these scores could be attributed to temperament and BookStart. The language score consisted of a composite measure of word level knowledge, formed by averaging z-scores for receptive and expressive word knowledge ( $r = .53$ ,  $n = 584$ ). As control variables we entered age in months at T2, education level, and gender as the first step. Results revealed significant positive effects for age (older children scoring higher),  $t(580) = 12.86$ ,  $p < .001$ , and gender (boys scoring lower),  $t(580) = 5.43$ ,  $p < .001$ , but not for education level. In step 2, temperamental reactivity and BookStart were entered. There was a main effect of temperamental reactivity on language,  $t(578) = -2.39$ ,  $p = .017$ ), but none of BookStart. The interaction between BookStart and temperamental reactivity, entered as a next step, was significant,  $t(577) = 2.30$ ,  $p = .022$ , indicating that it was especially temperamentally highly reactive children who benefited from BookStart. Excluding the covariates from the analysis did not change the regression effects (Simmons, Nelson, & Simonsohn, 2011).

To create a plot of predicted values of MacArthur-Bates CDI scores for the temperament groups (Figure 1), the temperament scale was split into the 25% scoring highest on temperamental reactivity ( $n = 144$ ) versus the 75% lowest ( $n = 440$ ). In the low-reactive group BookStart was nonsignificantly related to MacArthur-Bates CDI scores,  $\beta = -.04$ ,  $p = .331$ . The effect size in this subsample was weak ( $d = .05$ ; see Figure 1 and Table 2). However, BookStart was relatively strongly and significantly related to MacArthur-Bates CDI scores for children among the 25% highest scoring on temperamental reactivity,  $\beta = .20$ ,  $p < .007$  (see Figure 1 and Table 2). The effect size of BookStart in this subsample was moderately strong ( $d = .46$ ).

**Table 3** Descriptives of home activities in BookStart and Control group

Activity	Time	BookStart ( <i>n</i> = 359)	Control ( <i>n</i> = 225)
Shared reading	1	2.20 (.77)	2.00 (.95)
	2	2.57 (.60)	2.44 (.69)
Rhyming	1	1.66 (1.10)	1.63 (1.17)
	2	1.58 (1.13)	1.55 (1.09)
Singing songs	1	2.78 (.48)	2.78 (.49)
	2	2.72 (.56)	2.71 (.55)
Storytelling	1	2.09 (.97)	1.99 (1.02)
	2	1.96 (.99)	1.92 (1.07)
Listening to music	1	2.12 (.86)	2.19 (.96)
	2	2.21 (.80)	2.26 (.86)
Watching television	1	1.55 (1.14)	1.70 (1.11)
	2	1.80 (1.12)	1.88 (1.10)
Use of (internet) applications	1	.32 (.74)	.33 (.73)
	2	.70 (.93)	.68 (.96)

*Note.* Scores ranged from 0 (never) to 3 (daily).

**Table 4** Partial correlations between BookStart, parent child activities at home, and language skills controlled for age, gender, and education level

	BS	Verbal	Media	CDI
BookStart	---	.19*	-.02	.23**
Verbal parent-child interaction	.04	---	.03	.42***
Exposure to media	-.09	-.04	---	.21*
CDI	-.05	.24***	.10*	---

*Note.* Below diagonal correlations for children demonstrating low to average scores on temperamental reactivity (*df* = 437) and above diagonal correlations for highest scores on temperamental reactivity (*df* = 141)

### **Diathesis-stress or differential susceptibility?**

To make a distinction between diathesis-stress and differential susceptibility we tested if the nature of the BookStart-by-temperament interaction was ordinal or disordinal. We estimated the crossover point and CIs following Widaman's procedure. The point estimate of the crossover point,  $\hat{C} = -(.321/- .436) = .74$  ( $SE = .17$ ), 95% CI [.40, 1.07], fell slightly above the sample mean of the dummy variable BookStart ( $M = .61$ ;  $SD = .487$ ). The lower limit of the CI for  $\hat{C}$  fell .43  $SD$  units below the sample mean of dummy variable BookStart, and the upper limit fell .94  $SD$  units above the sample mean. According to Widaman et al. (2012), given that  $\hat{C}$  falls within the range of the dummy variable 'BookStart', the interaction in the current sample is disordinal, which indicates differential susceptibility. The CI for  $\hat{C}$ , however, covers values that, to the right of the crossover point, fall outside the range of the dummy variable (grey areas in Figure 1). With the CI for  $\hat{C}$  falling partly outside the range of BookStart we cannot reject the hypothesis of an ordinal (diathesis-stress) model in the population (Widaman et al., 2012).

### **Parent-child verbal interactions as mediator**

We expected the gains in language made by the BookStart group to be the result of an increase in exposure to verbal input. As indicator of home activities we calculated the sums of the two assessments (T1 and T2) for all home activities. Scores on singing songs and playing with apps were dropped, due to ceiling effects for singing songs and bottom effects for apps (Table 3).

PCA applied to the home activities revealed two components, together explaining 65% of variance. The first component (explaining 44%) covered activities that included *verbal parent-child interaction*: book reading (.75), the parent telling stories to the infant (.84), and reciting rhymes (.71); alpha-reliability equaled .68. The second component (*exposure to media*), explaining 21%, included listening to music (.61) and watching television (.91); alpha-reliability equaled .41. The distribution of the aggregated variables was normal for both the BookStart and the control groups.

As a next step, we carried out mediation analysis in the group with temperamentally highly reactive children, where BookStart predicted language skills. We tested whether effects of BookStart on language skills resulted from an increase in verbal parent-child interaction and/or media exposure, controlling for variation in age via techniques as described by Preacher and Hayes (2008). Partial correlations (controlling for children's age, gender, and education level) among measures that were included in mediation analysis are shown in Table 4, for temperamental reactivity groups separately.

BookStart was a significant predictor of language development (c-path; point estimate = .37 ( $SE = .14$ ),  $t(143) = 2.72$ ,  $p = .007$ ) and verbal interaction ( $a_1$ -path; point estimate = .40 ( $SE = .18$ );  $t(143) = 2.27$ ,  $p = .025$ ), but was not related to media exposure ( $a_2$ -path; point estimate = -.05 ( $SE = .18$ );  $t(143) = -.27$ ,  $p = .79$ ). Verbal interaction was a significant covariate of language skills ( $b_1$ -path; point estimate = .30 ( $SE = .06$ );  $t(143) = 5.07$ ,  $p = .000$ ), as was media exposure ( $b_2$ -path; point estimate = .16 ( $SE = .06$ );  $t(143) = 2.74$ ,  $p = .007$ ). BookStart remained a significant predictor of language skills if entered simultaneously with verbal interaction and media exposure, but the effect was less significant ( $c_1'$ -path; point estimate = .26 ( $SE = .13$ );  $t(143) = 2.07$ ,  $p = .041$ ). We bootstrapped the indirect effect of BookStart on language and found that verbal interaction was a significant mediator between BookStart and language (point estimate = .1195 ( $SE = .0588$ ); 95% Bias Corrected CI [.0272 - .2703]; 95% Bias Corrected and accelerated CI [.0272 - .2713]), whereas media exposure was not (point estimate = -.0078 ( $SE = .0292$ ); 95% Bias Corrected CI [-.0744 - .0470]; 95% Bias Corrected and accelerated CI [-.0741 - .0477]). The total indirect effect of BookStart through the two mediators had a point estimate of .1117 with a 95% BCa bootstrap CI of .0010 to .2788, indicating that the mediators add significantly to the model. The model, with only verbal interaction as mediator, explained 40% of the variance in language outcome. In all regressions required for testing mediation, age, and gender were significant covariates ( $p$ 's < .05), but education level was not (point estimate = -.0174,  $p = .72$ ). Excluding the covariates from the analyses did not significantly change the regression effects in the model (Simmons et al., 2011).

## Discussion

BookStart did not cause any direct effects on language development in an average Dutch sample including the whole range of low- to high-educated families. BookStart shows effects when children have a highly reactive temperament, whereas the effects are not significant in a less temperamentally reactive group. Our results were in line with research on differential susceptibility, as appears from the finding that temperamentally reactive infants are more at risk for language delays but outperform less reactive peers if parents participate in BookStart. Parents may be less inclined to initiate verbal interactions with reactive children, but become more motivated through BookStart to initiate interactions despite negative responses of the child.

**Parent-infant verbal interaction as mediator**

As a result of BookStart, parents initiate more verbal interactions with their infants, to stimulate early language development despite negative behavior on the part of the child. In the group showing temperamentally reactive behavior, the BookStart group's score on verbal interaction ( $M = -.06$ ) was higher than the score in the control group ( $M = -.46$ ), whereas scores in the temperamentally less reactive group were equally high for the BookStart ( $M = .11$ ) and control group ( $M = .03$ ). The results of the mediation analysis indicate that language development is promoted via activities that imply parent-infant verbal interactions: book reading, reciting rhymes, and telling stories. In the temperamentally highly reactive group, verbal interactions as they occur while sharing a book, rhymes, or stories, partly mediate the improvements in children's word-knowledge assessed when children are on average 15 months old. In sum, BookStart stimulates parents of temperamentally highly reactive children to interact verbally with their baby despite negative responses of their child, and thus stimulate language skills.

**Support for a disordinal, differential susceptibility model**

Our findings support the conclusion that high temperamental reactivity is a risk under suboptimal conditions but an asset under optimal conditions, in line with the differential susceptibility model (Belsky et al., 2007). According to our results, under less favorable learning conditions temperamentally reactive children lag behind their less reactive peers, regarding language, but they are likely to benefit from an optimal environment as created by BookStart. These results are in accordance with previous research in other domains which has shown that temperamentally reactive children thrive under supportive caregiving and then even outperform their less reactive peers in social-emotional development (Poehlmann et al., 2012; Blair, 2002). As indicated in previous experiments on differential susceptibility with 4- and 5-year-olds (Kegel et al., 2011; Van der Kooy-Hofland et al., 2012), our current results show that some children are more susceptible to aspects of the learning environment, whether good or bad for better and for worse. BookStart not only has a protective effect when children are at risk of a delay in cognitive development, but enables the more malleable children to perform at the top of their learning potential.

On the basis of the results presented here, we cannot fully reject the hypothesis of an ordinal diathesis stress model. The interval around the point estimate of the crossover point indicates that in other samples children with a highly reactive temperament may catch up under the influence of BookStart, but will not outperform their less reactive peers under optimized learning conditions as we found in the current



sample. BookStart only prevents temperamentally reactive children from receiving insufficient incentives to develop early language skills. We expect, however, that more suggestions for structuring interactions between parents and temperamentally highly reactive children may result in full support for the differential susceptibility model. For instance, libraries might offer optional parental training for parents of temperamentally highly reactive infants, and provide tips for dealing with unpleasant child responses.

### **Limitations**

An important limitation of this study is the quasi-experimental nature of the design. An unavoidable element of BookStart is self-selection, given that parents are free to collect or ignore the BookStart materials, and make use of the library and the support offered or not. Parents dissatisfied with their child's responses in attempts to initiate verbal interactions may be more inclined to ignore the invitation and not participate in BookStart. Therefore, we may have missed the most temperamentally reactive children in our present sample and hence a chance to establish the differential susceptibility model beyond doubt.

Also due to the self-selection the lowest educated families were underrepresented, although they may be most in need of a program such as BookStart. After visits to the homes of 42 families from various socio-economic backgrounds, to assess the ways in which daily exchanges between a parent and child shape language and vocabulary development, Hart and Risley (1995; 2003) found unprecedented disparities between the sheer number of words spoken as well as the types of messages conveyed. Thus, in our sample self-selection may also have reduced the variation in activities that imply infant-child verbal interaction, which in turn may have reduced variance explained by BookStart.

On the other hand, BookStart could be particularly effective in an average sample, because average or highly educated parents do not need coaching in how to interact verbally with infants, but merely incentives to initiate interactions despite their child's difficult behavior. Parents who are not used to verbal interaction with babies might need more support than BookStart offers. As a critical test of the underrepresentation of lowest educated risk families and behaviorally difficult children, future research should, unlike our study, also incorporate parents who received an invitation for BookStart but did not collect the materials or make use of the free advice by librarians or workshops.

A final limitation is our use of questionnaires to assess activities at home. This may have reduced variation in actual behavior, because parents are inclined to report

behavior that they consider to be socially desirable. Besides parent reports of their interactive activities future studies should also incorporate observational data.

### **Conclusion**

Although BookStart only provides sample materials for babies, access to similar materials at the library, and advice on request, the program did enhance language development in part of our sample. The program stimulates parents to initiate verbal interaction with their infants in a temperamentally highly reactive group. In the complete sample, the effect size was low ( $d = .05$ ), but substantial - slightly less than half a standard deviation ( $d = .46$ ) - in a subsample of temperamentally highly reactive infants. When infants exhibit difficult behavior during daily routines, they may be more sensitive or reactive to environmental input and easily irritated; if parents consistently fail to involve these children in verbal interactions this may be particularly deregulating for language growth. When their parents receive BookStart materials and suggestions, and continue to involve their child in verbal interactions despite the child's negative responses, children score higher on language skills than their less reactive peers (Figure 1). Our results therefore support the idea that temperamentally reactive children are more susceptible to the environment than less reactive peers; they are at risk of lagging behind under suboptimal learning conditions, but at the same time can outperform their peers under optimal conditions created with the help of BookStart. Results suggest that BookStart is especially vital for temperamentally highly reactive children. We expect the effects of BookStart at 15 months to extend to later development, because they may set in motion a pattern of reciprocal influences that may cause language and cognitive development to "snowball" (Raikes et al., 2006), thereby creating more opportunities to enrich later oral language, literacy, and comprehension skills (e.g., Mol & Bus, 2011). Such long-term effects need to be examined in follow-up research to our study.

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