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A Parent Intervention with a Growth Mindset Approach Improves Children's Early Gesture and Vocabulary Development

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Abstract

Socioeconomic disparities in children's early vocabulary skills can be traced back to disparities in gesture use at age one and are due, in part, to the quantity and quality of communication children are exposed to by parents. Further, parents' mindsets about intelligence contribute to their interactions with their children. We implemented a parent gesture intervention with a growth mindset component with 47 parents of 10-month-olds to determine whether this approach would increase parents' use of the pointing gesture, infants' use of pointing, and child vocabulary growth. The intervention had an effect on parent gesture such that by child age 12-months, parents who received the intervention increased in their pointing more than parents in the control condition. Importantly, the intervention also had a significant effect on child gesture use with parents. There was no main effect of the intervention on child vocabulary. Further, the effect of the intervention on pointing was stronger for parents who endorsed fixed mindsets at baseline, and had an added benefit of increased vocabulary growth from 10–18 months for children of those parents who endorsed fixed mindsets. Incorporating growth mindset approaches into parenting interventions is encouraged.

Keywords

pointing; intervention; mindset; gesture; parenting

The income-achievement gap in reading is large and statistically significant at the beginning of kindergarten in the United States (Reardon, 2013). Kindergarteners' vocabulary skill, in particular is the strongest predictor of later reading success, and the relation between socioeconomic status (SES) and children's later reading skills is mediated by children's kindergarten vocabulary skills (Durham, Farkas, Hammer et al., 2007). Thus, one approach to prevent income-achievement gaps in reading is to focus on promoting low-income children's vocabulary during early childhood.

Average SES differences in vocabulary emerge as early as 18-months (e.g., Fernald, Marchman & Weisleder, 2013) and can be traced back to children's early use of gesture, particularly pointing gestures (e.g., Rowe & Goldin-Meadow, 2009); differences in gesture at 14–15 months predict vocabulary size in preschool (Kuhn, Willoughby, Wilbourn et al.,

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2014) and kindergarten (Rowe & Goldin-Meadow, 2009). Language and literacy development is a domain where skills build upon skills, with one example being the progression from gesture to vocabulary to reading comprehension. Interventions addressing early foundational skills such as gesture may have a larger effect than interventions starting once the gap has already emerged.

One approach to promoting children's early vocabulary skills is to focus on parent-child communication, given established associations between SES, the quantity and quality of parental talk with children, and children's own vocabulary growth (e.g., Hart & Risley, 1995; Hoff, 2003; Huttenlocher et al., 2010). Similar associations are also evident in gesture: SES-differences in child gesture at 14-months are mediated, or explained, by parents' use of gesture, controlling for parents' talk (Rowe & Goldin-Meadow, 2009). Even before children produce verbal language, they are socialized to communicate more or less and in different ways, through their interactions with their parents, which affects their learning (e.g., Bruner, 1983; Kuhl, 2007; Snow, 1977; Vygotsky, 1978).

Existing interventions targeting parent-child communication use a variety of approaches. One focus is to provide parents with information about child language development. Research shows that SES differences in parents' talk to children are due, in part, to parents' knowledge about child development (Rowe, 2008; Vernon Feagans, et al., 2008). Thus, boosting parents' knowledge of the topic might influence how they communicate with their children. Recent interventions of this sort have had short-term success influencing parent input and child language outcomes (e.g., Leech, Wei, Harring & Rowe, 2018; McGillion, Pine, Herbert & Matthews, 2017, Suskind, Leffel, Graf et al., 2016).

In the current study, in addition to providing parents with knowledge about child language development, we were interested in whether embedding a growth mindset (Dweck, 1999) component would be effective. This interest grew out of previous research showing that parents who endorse a growth mindset (believe that intelligence is malleable) report engaging in math and literacy activities with their preschool-aged children more than parents with more fixed mindsets (believe that intelligence is static) (Muenks, Miele, Ramani et al., 2015). Further, priming parents (Moorman & Pomerantz, 2010) and teachers (Good, Rattan & Dweck, 2007) to hold growth mindsets causes them to interact with their school-aged children in more supportive ways that promote hard work. And a recent reading intervention encouraging parents to praise their second-grade children's effort rather than performance (to promote growth mindset in children) led to increases in children's reading abilities (Andersen & Nielson, 2016). Importantly, in this study, effects were especially strong for the children whose parents initially believed their child's abilities were relatively fixed. Thus, a growth mindset approach towards parenting interventions may be particularly useful for parents with more fixed mindsets and to our knowledge, no prior studies have tested the effectiveness of embedding a growth mindset approach in a parent-focused intervention to promote early vocabulary development.

Typically-developing children start using the pointing gesture after 10-months (Carpenter, Nagell, Tomasello et al., 1998). Several studies show concurrent and longitudinal associations between parent and infant pointing, but the directionality of the effects has not

been well established (e.g., Rowe & Goldin-Meadow, 2009; Liszkowski & Tomasello, 2011). A training study with parents of 9- to 11-month-olds (Matthews, Behne, Lieven & Tomasello, 2012) failed to provide positive evidence for a causal direction, however a cross-cultural study (Salomo & Liskowski, 2013) adopting a quasi-experimental comparison of naturally occurring differences in parent gestures suggests a directional influence from parent pointing to infant pointing. Thus, we chose to focus on parents of 10-month-olds who should be in the early stages of pointing production, and to focus on increasing parents' use of gesture to promote child gesture and, ultimately, vocabulary development. Our primary research question is:

1. Can a parent-focused gesture intervention with a growth mindset approach increase parent use of gesture, child gesture use with parents, and early child vocabulary development?

A secondary question is:

2. Does the intervention work better for parents from different SES backgrounds (education level) or who hold different intelligence mindsets at baseline?

Method

Participants

Fifty parents and their 10-month-old infants were recruited to participate in a study on play and development via direct mailings and community and social media advertisements in a large metropolitan area in the Northeast US. An a-priori power analysis for the effect of the intervention determined that N=40 would provide 80 percent power to detect a medium effect size (0.15) with an alpha level of 0.05 and three predictors in the regression model. We used census data to target zip codes that would allow us to recruit a socioeconomically diverse sample and recruited 50 families, assuming attrition over the course of the study. The final analytic sample size was 47: two dyads were excluded due to inability to contact the parent after baseline, and one family was excluded because the target caregiver changed during the study. We acknowledge that analyses for our second research question about moderation effects are exploratory and may be under-powered.

The parent sample was comprised of mothers and one grandmother, who designated herself as the child's primary caregiver. Thirty-four parents were White, four were Black, and the remaining nine parents described themselves as Mixed Race or Other. Children (25 girls, 22 boys) had no known developmental or language delays, heard English at least 75 percent of the time at home, and were not born prematurely (defined as prior to 37 weeks). At the onset of the study, children averaged 10 months and 7 days (10;7) (Range = 9;7–11;6).

Procedure and Measures

Data were collected in participants' homes by a trained researcher every two months from child age 10-months to 18-months. All parents were told that the purpose of the study was to better understand the benefits of play for child development.

Baseline visit.—Prior to random assignment, the parent completed questionnaires to collect information regarding family demographics, the child's current vocabulary ability, and the parent's intelligence mindset. Maternal education was used as the measure of family socioeconomic status. On average, parents had 15.6 years of education (SD = 2.14), though the range was large, from 10 years (less than high school degree) to 18 (master's degree or higher). Education was normally distributed with 47 percent of the parents having less than a college degree and 53 percent having received at least a college degree. We measured parents' intelligence mindsets using the 8-item Theories of Intelligence questionnaire constructed by Dweck (1999), which includes four fixed statements (e.g., *You have a certain amount of intelligence and you can't really do much to change it*) and four incremental statements that were reverse coded (e.g., *You can always change how intelligent you are*). Parents responded on a 6-point Likert-type scale to each item ranging from 1 (*Disagree Strongly*) to 6 (*Agree Strongly*) (M = 2.22; SD = 1.12; Range = 1.0–5.40)[1]. To measure children's receptive and productive vocabulary, parents completed the McArthur Bates Communicative Development Inventory MB-CDI (Fenson et al., 1994) short-form checklist, which consists of 89 lexical items and instructs the parent to indicate which words the child knows (receptive scale) and says (production scale). At 10-months, children's receptive vocabulary averaged 8.93 words (SD = 7.91; Range = 0–34), and production averaged 0.82 words (SD = 1.25; Range = 0–5).

Following completion of the questionnaire battery, the researcher videotaped the dyad engaging in a semi-structured play session which served as a baseline measure of parent and child gesture and language use. During this interaction, the dyad played with the contents of three bags containing a developmentally appropriate book and two toys for fifteen minutes. After the parent-child interaction was complete, families were randomly assigned to the intervention or control group.

Intervention materials and procedure.—Intervention parents then received a brief training program that emphasized that their children's language development is malleable and that they can play an important role in shaping that development. The main component of the program was a five-minute video, *Pointing to Success*, that included information about the importance of pointing, videos of dyads engaging in play with pointing, and importantly, repeated growth mindset messaging that children's language development is malleable and parents can help their children's language grow by pointing and encouraging their child's pointing use. Immediately following the video, the experimenter engaged the parent in a short conversation about the video as a comprehension check. The experimenter then gave the caregiver developmentally appropriate toys as a gift and encouraged her to play with her child 15 minutes per day and to point as much as possible during this time. Control parents also received an identical set of toys, but not the accompanying pointing information or instructions. Researchers texted intervention parents weekly between child age 10- and 12-months – the time that, on average, children begin to point – to remind them to play and to reinforce the training message that pointing matters for their child's language development.

[1]Analyses including the theories of intelligence questionnaire included a sample of n=45 due to missing questionnaire data from two families.

Follow-up home visits.—The researcher returned to each dyad's home when the child was 12-, 14-, 16-, and 18-months-old for a 45-minute visit. Procedures were identical for the control and intervention conditions: the parent completed the MB-CDI and the dyad participated in a 15-minute videotaped play session identical to baseline procedures. At the final visit at 18-months, the experimenter administered the Expressive Language subscale of the Mullen Scales of Early Learning with the child (Mullen, 1995). Of the possible 235 video recordings, 17 recordings were missing due to inability to schedule a visit within two weeks of the scheduled date (n=15) or infant fussiness (n=2). All parents were compensated with $20 per visit.

Parent and child gesture outcomes.—Videotaped parent-child interactions were transcribed for verbal and nonverbal communication by trained research assistants using the conventions of the Child Language Data Exchange System (CHILDES) (MacWhinney, 2000). The unit of transcription was the utterance, defined as talk that ends by transition in speaker, grammatical closure, or a pause. A second research assistant independently verified each transcript, paying close attention to speech accuracy, and accuracy of utterance boundaries.

A research team then further coded parent and child pointing from the transcripts. A point was defined as any parent or child use of the index finger to indicate something in the environment. All points were counted whether or not they were accompanied by gaze or vocalizations. Whole hand (palm) points were not included. For recordings less than fifteen minutes (n=10), measures were calculated per-minute and then adjusted to yield a value per 15-minutes. One research assistant who was blind to condition assignment led the coding team, and the remainder of the team was blind to both study hypotheses and condition assignment. Consistent with previous research on parent and child pointing measures most related to child language development (Goldin-Meadow, Mylander, de Villiers, 1984), we focused on two dependent measures for parents and children: *pointing tokens,* or the sheer number of pointing gestures produced by the individual, and *pointing vocabulary*, or the number of different meanings the individual conveyed via the pointing gesture (e.g., point at dog two times equals 2 pointing tokens and 1 pointing type "dog"). Percent agreement on the pointing coding scheme ranged from 89 to 91 percent. At baseline, parents used 20.38 pointing tokens (SD = 13.63; Range 3–67) and their pointing vocabulary averaged 9.28 (SD = 4.64; Range 3–22). Thirty-four percent of children were observed using at least one pointing gesture at the baseline (10-month) visit. On average, children used 1.38 pointing tokens (SD = 3.78; Range = 0–22), and pointing vocabulary averaged 0.85 (SD = 1.82; Range = 0–10).

Child vocabulary outcomes.—The children's scores on the MB-CDI receptive and productive vocabulary scales at each visit served as the longitudinal vocabulary outcomes, and the children's scores on the expressive vocabulary subscale of the Mullen Scales of Early Learning at 18 months was an additional outcome. The MB-CDI is a reliable parent-report instrument for measuring vocabulary in children this young (Fenson et al., 1994). The Mullen is experimenter administered and a compliment to the parent report data.

Results

Independent samples *t* tests run on baseline data confirmed random assignment such that there were no condition differences in parent or child pointing, maternal education, or intelligence mindsets, *p*'s > 0.05. Further, parent and child pointing were positively correlated at baseline (r = .38 *p* = .008), but neither parent nor child pointing was correlated with maternal education or theories of intelligence, *p*'s > .35. Finally, while not the focus of the analyses, there were no condition differences in parent or child quantity or diversity of speech at baseline, *p*'s > 0.05, and parent vocabulary (i.e., word types) at baseline was associated with parent education (*r* = .38, *p* =.009).

Table 1 presents descriptive statistics for parent and child pointing and child vocabulary measures over time for the intervention and control groups. In presenting the results we first address the primary research to determine whether there is a main effect of the intervention on parents' pointing with children, children's pointing with parents, and child vocabulary growth. Then, we address the second, more exploratory question about moderating effects of parent education and mindset.

Did the intervention affect parent and child pointing?

We examined whether the intervention resulted in an increase in parent and child pointing by regressing pointing outcomes at child age 12-months on a dummy-coded condition variable (0=control; 1=intervention) while controlling for pointing at baseline. Results indicated that the intervention caused a significant increase in parents' quantity of pointing (tokens), such that parents who received the intervention pointed, on average, 13.25 times more (SE = 5.74; 95% CI = 1.67, 24.82) than parents randomized into the control condition, $t(44) = 2.31$, $p = .03$, $R^2 = 0.18$. Significant intervention effects were also observed for parent pointing vocabulary, with intervention parents pointing to or about 2.25 more objects (SE = 0.33; 95% CI = 0.74, 9.80) than parents randomized into the control condition, $t(44) = 2.35$, $p = .02$, $R^2 = 0.16$. The intervention effects were limited to parent gesture and not evident in parent word tokens or types.

Intervention effects were also observed for children at 12 months: children whose parents received the intervention pointed significantly more (M = 2.03; SD = 0.83; 95% CI = 0.36, 3.70), $t(44) = 2.45$, $p = 0.02$, R^2=.38, and demonstrated a larger pointing vocabulary (M = 1.27; SD = 0.63; 95% CI = 0.003, 2.54), $t(44) = 2.02$, $p = .05$, $R^2 = .42$, than children of control parents.

Next, we examined whether longer-term effects were observed on pointing outcomes. While intervention parents continued to point more than control parents at subsequent visits (Table 1), there was no longer a significant difference between conditions in their quantity of pointing or pointing vocabulary. For example, at 14-months, while intervention parents' pointing tokens (M = 41.34) were higher than control parents (M = 36.24), this difference did not reach significance, $t(42) = 0.84$, $p = .41$, 95% CI = −7.23, 17.42). Condition differences in child pointing at the three final times were also not significant. Thus, while intervention effects on pointing were robust at 12 months they faded over time.

Did the intervention affect child vocabulary?

We examined whether the intervention resulted in an increase in children's vocabulary growth between 10- and 18-months measured by the MB-CDI and at 18-months as measured by the Mullen. For the longitudinal CDI analyses, we fit two-level models with random intercepts. At level 1, we estimated each child's growth in receptive and productive vocabulary between 10- and 18-months. Level 2 of the model determined whether the trajectories could be predicted by condition. Following conventions of Singer and Willet (2003), we person-centered age at 12-months, so that our parameters were more interpretable and referred to each child's language ability and instantaneous growth at 12-months rather than 0-months (as would have been the case without centering). The main effect of the intervention was not significant for MB-CDI comprehension (Table 2, Model 2) or production (Table 3, Model 2) outcomes. Similarly, regression analyses indicated no main effect of the intervention on the Mullen at 18-months ($t = -0.32$, $p = .75$). Thus, in sum, there was no main effect of the intervention on child vocabulary.

Did parent education or intelligence mindsets moderate intervention effects on pointing?

We next examined whether maternal education or intelligence mindsets moderated the changes in parent or child pointing. Linear regression analysis was used to predict parent pointing when children were 12-months from baseline pointing, condition, and the effect of maternal education or mindsets. Table 4 (Models 1 & 3) shows that the intervention worked equally well for parents from all education backgrounds. Similarly, the addition of a maternal education by condition interaction was not significant for either child pointing variable (Table 4, Models 5 & 7).

In the second moderation analysis, adding the interaction between intelligence mindsets and condition resulted in a significantly better model fit for parents' pointing tokens (Table 2, Model 2) but not pointing vocabulary (Table 4, Model 4). Figure 1 (Panel A) illustrates that the effect of the intervention on change in maternal pointing differed by baseline maternal mindsets, with larger effects for parents who endorsed more fixed mindsets. No mindset by condition interaction was observed for child 12-month pointing tokens (Table 4, Model 6), yet mindsets did moderate the condition change in child pointing vocabulary (Table 4, Model 8; Figure 1, Panel B). Thus, the effect of the intervention on child pointing vocabulary was particularly strong for children whose parents endorsed fixed mindsets at baseline (Figure 1 Panel B).

Did parent education or intelligence mindsets moderate intervention effects on vocabulary?

As noted earlier, the main effect of the intervention was not a significant predictor for MB-CDI comprehension (Table 2, Model 2) or production (Table 3, Model 2) growth outcomes. To examine the potential moderators, we added the effect of parents' baseline intelligence mindsets which was also not a significant predictor of vocabulary growth (Table 2, Model 3; Table 3, Model 3). However, the interaction between intervention group and parents' intelligence mindsets was significant such that intelligence mindsets moderated intervention effects in both comprehension (Table 2, Model 4), z = 1.15, [95% CI: 0.26, 2.03], and production (Table 3, Model 5), z = 1.04, [95% CI: 0.29, 1.79].

In Figure 2, we display the interaction effect by plotting the regression output from Model 5 (Table 3) to show the estimated growth in vocabulary production for children of parents with growth-mindsets (10th percentile of the sample; a score of 1) versus fixed-mindsets (90th percentile of the sample; a score of 4) in each condition. For children whose parents initially endorsed fixed mindsets and received the intervention, estimated vocabulary production increased at a rate of 2.51 words per month faster than children whose parents who endorsed fixed mindsets but were in the control condition. Results were similar for vocabulary comprehension. These findings hold when controlling for children's pointing at the baseline 10-month visit.

Finally, we ran a parallel analysis predicting children's expressive language scores on the Mullen at 18-months. Mullen scores were significantly positively correlated with MB-CDI scores at 18-months ($r = .58$, $p < .01$ for production; $r = .41$, $p < .01$ for comprehension). Regression analysis indicated no main effect of condition or parents' intelligence mindsets on Mullen scores. However, an interaction between condition and intelligence mindsets emerged, $t = 2.16$, $p = .04$ [95% CI: 1.19, 38.23]. This interaction is plotted in Figure 3, and corroborates the pattern found in the MB-CDI analyses that the intervention had more of an effect on children's expressive language as measured by the Mullen for children of parents in the intervention group who had fixed mindsets at baseline. These results hold when controlling for parent education which is positively correlated with the Mullen at 18-months ($p<.05$). However, all of the moderating effects should be interpreted with caution, as our sample was underpowered to detect them.

Discussion

Our *Pointing to Success* intervention increased parent pointing and child pointing with parents between child ages 10–12 months. We did not find a main effect of the intervention on child vocabulary growth or skill at 18-months. We first discuss the importance of these primary findings, followed by some speculations about our secondary moderating effects of parental intelligence mindsets.

Our intervention targeted pointing gestures of parents of 10-month-olds because we know there is an association between parent and child gesture use, yet the extant work is largely correlational. That is, parents within and across cultures differ in the amount that they gesture with their children, and consistent associations are found between parent and child pointing during the same interactions (e.g., Salomo & Liszkowski, 2013; Rowe & Goldin-Meadow, 2009). Our findings add to this literature by providing some causal evidence for the social-mediation perspective that parent use of gesture influences child use, as we found that experimental increases to parent pointing increased children's pointing during interactions with parents. However, we cannot speak to whether these children developed over the two-month intervention period into more frequent pointers, or if they increased their pointing ad hoc during the actual interaction session with their parents. Indeed, the training study by Matthews and colleagues (2012) showed no effect of a parent pointing training on children's ability to point.

We found that parent education was positively related to parent talk with children at 10-months, but not to parent gesture. This was somewhat surprising, however variation in parent gesture measures was smaller than parent speech measures so education effects may be harder to detect, or it could be that education effects on parent gesture do not appear until later when children are gesturing more themselves. Further, intervention effects seen at 12-months did not differ by parent education. This is important because 12-months is still earlier than the earliest age (14-months) at which other studies have found that SES differences in child gesture exist and predict later skills (e.g., Kuhn et al., 2014; Rowe & Goldin-Meadow, 2009). Thus, it may be possible to increase child skills and reduce achievement gaps before they substantiate.

A limitation of our design is that since the control group was also given toys, and we know that play in general promotes language development (Weisberg, Zosh, Hirsh-Pasek & Golinkoff, 2013), the overall intervention effects may be smaller than if we had included a control group who received nothing or an unrelated treatment. Nonetheless, it is notable that this relatively "light-touch" approach – a one-time five-minute video, plus several text messages – resulted in significant short-term change in parents' use of pointing over and above a control group of this sort. One potential reason for the fade-out effects over time could be that parents only received text reminders between 10- and 12-months, raising the question whether another "boost" of information about the importance of pointing and parents' role in promoting their child's development would help retain results.

Our secondary, more exploratory analysis found that children of parents who endorsed more fixed mindsets at baseline and who were in the intervention group increased more in pointing, had faster vocabulary growth between 10–18 months and greater expressive language skills at 18-months than children of parents who also endorsed fixed mindsets but were in the control group. Thus, incorporating growth mindset messages about parenting into interventions (e.g., your child's language development is malleable and you can make a big difference in their language learning) may be an effective way to enact change in parent communication and improve child language development, especially for parents who believe intelligence is more fixed.

The current results suggest that helping parents who believe their child's intelligence is relatively fixed to understand the important role they play in their child's development may be an important component of intervention. Our results mirror those found in a recent reading intervention (Andersen & Nielson, 2016) where the mindset approach focused on parents' praise of children's hard work rather than intelligence. Because of the different developmental stages of the children in question (10-months in our case; 8 years in Andersen & Nielson, 2016) the substantiation of the mindset approach in the intervention differed. Thus, in the current study the focus was on parents' understanding that their child's language development is not fixed and that they can influence its course by how they gesture with their children. There are likely other ways to address parents' mindsets through interventions that are more or less targeted. For example, many of the priming studies (e.g., Moorman & Pomerantz, 2010) induce growth or fixed mindsets in parents by providing them with fake empirical articles about how malleable the brain is (or isn't) in development. It is an open question whether this more general approach would be effective for targeted

language and literacy interventions. It is worth noting that over the course of our study for parents in the intervention group there was a 0.20 unit change in parents' intelligence mindsets (towards more growth-oriented), but this was not a significant change. The control group showed a similar size non-significant change, but in the opposite direction.

In conclusion, the current results broaden the growing literature showing short-term success with interventions targeting parent-communication with children (e.g., Leech et al., 2018; McGillion et al., 2017; Suskind, et al., 2016) and highlight the important role of parents' intelligence mindsets in this process. Interventions that take a growth mindset approach with school-aged children are successful in promoting academic skills and resilience in students (Yeager & Dweck, 2012). We suggest that this approach can also be useful with parents (e.g., Mueller, Rowe & Zuckerman, 2017). This simple mindset messaging might be just the kind of "nudge" (Thaler & Sunstein, 2008) parents need to promote behaviors at scale that positively contribute to their children's development during early childhood (Benartzi, Beshears, Milkman, et al., 2017).

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Research Highlights

- An intervention for parents of 10-month-olds increased parents' use of the pointing gesture with their children.
- The intervention also increased children's use of the pointing gesture during interactions with their parents.
- The effects of the intervention on parent and child pointing were stronger for families where the parents endorsed more fixed mindsets at baseline.
- The intervention resulted in increases in vocabulary development for children in families where parents endorsed fixed mindsets compared to similar families in the control group.

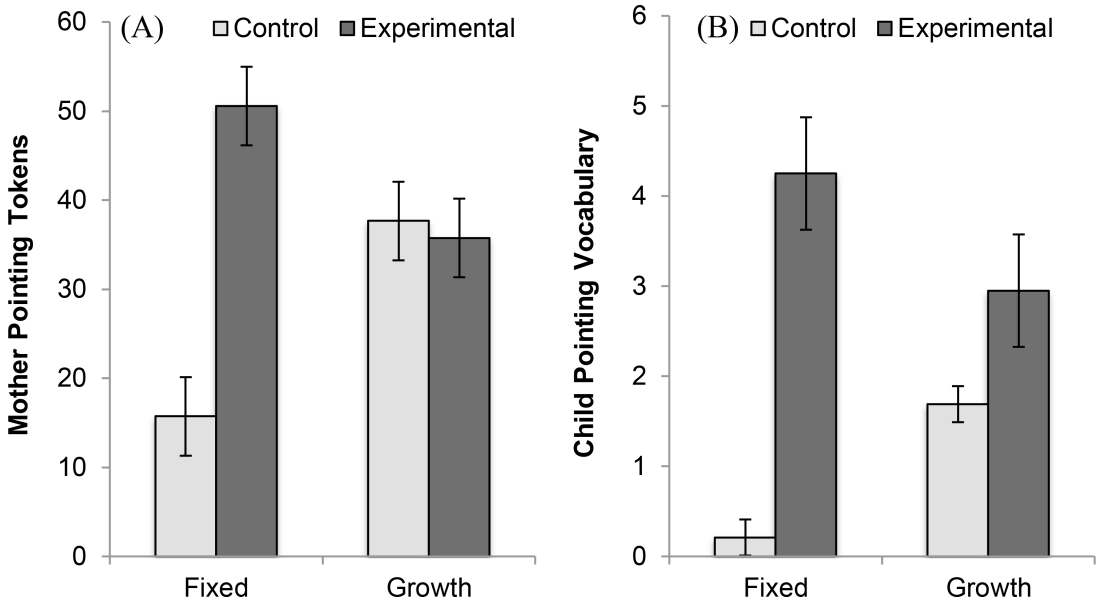

Figure 1.

Panel A illustrates that the change in amount of mother pointing from baseline to child age 12-months was significantly larger for parents who received the intervention and initially endorsed fixed mindsets compared to parents who endorsed fixed mindsets but did not receive the intervention. Panel B shows a similar pattern for change in children's pointing vocabulary from baseline to 12-months of age. Note that Growth and Fixed estimates were derived from the 10^{th} and 90^{th} percentile of the sample respectively.

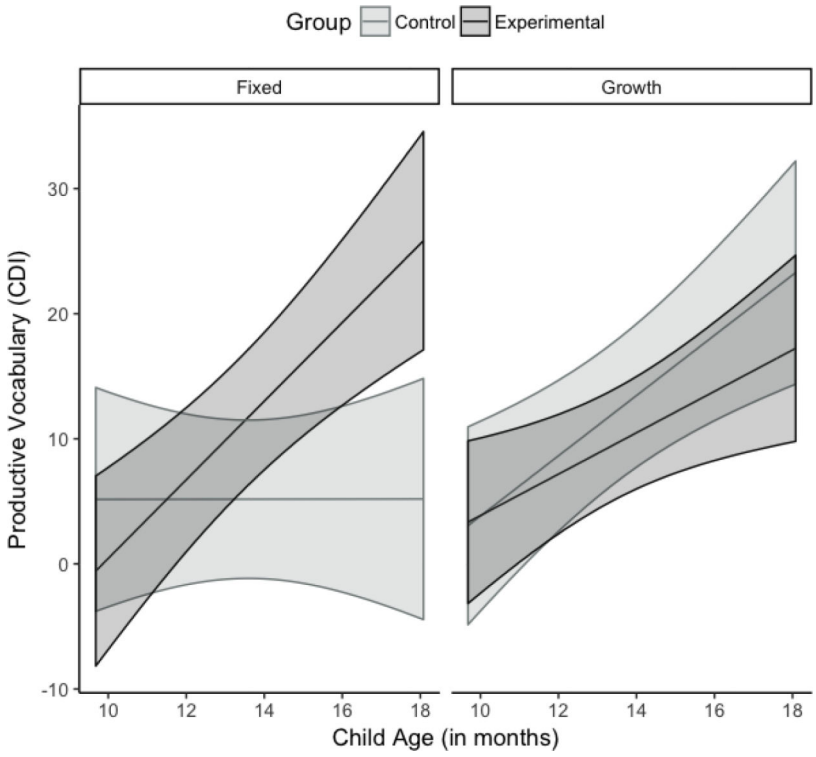

Figure 2.

Growth in productive vocabulary was predicted by an interaction between parents' intelligence mindsets (measured at baseline), and whether or not they received the pointing intervention (experimental versus control). The nature of the interaction was isolated to parents who initially endorsed fixed mindsets (left panel). For parents who received the intervention, their children's growth was similar to that of parents with growth mindsets, whereas growth was less steep for children whose parents were in the control condition. Note that Growth and Fixed estimates were derived from the 10^{th} and 90^{th} percentile of the sample respectively.

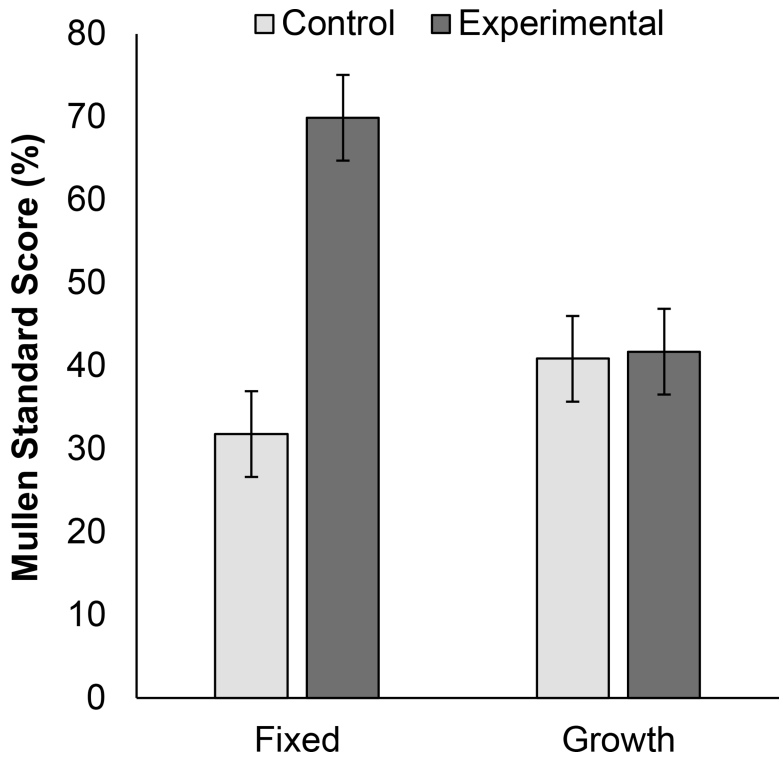

Figure 3.

Children's vocabulary size at 18-months as measured by Mullen Scales of Early Learning differed depending on the condition to which the parent was assigned and the parent's intelligence mindset. Vocabulary was largest for children whose parents who received the intervention and initially endorsed fixed mindsets compared to parents who endorsed fixed mindsets but did not receive the intervention. Note that Growth and Fixed estimates were derived from the 10th and 90th percentile of the sample respectively.

Table 1

Descriptive statistics M(SD) for parent pointing, child pointing, and child MB-CDI vocabulary at each visit for the intervention and control groups (N=47 total).

	10 months		12 months		14 months		16 months		18 months	
	Control	**Intervention**	**Control**	**Intervention**	**Control**	**Intervention**	**Control**	**Intervention**	**Control**	**Intervention**
Parent Pointing										
Tokens	22.54 (15.90)	18.13 (10.67)	28.86 (20.69)	41.00 (19.19)	36.73 (22.70)	40.67 (17.09)	39.33 (26.82)	42.48 (20.26)	36.62 (22.16)	40.65 (21.51)
Types	10.04 (5.03)	8.48 (4.16)	13.82 (8.61)	18.52 (6.72)	16.18 (8.57)	16.86 (5.53)	19.10 (9.04)	20.76 (7.77)	16.57 (7.35)	18.00 (7.23)
Child Pointing										
Tokens	0.67 (1.46)	2.13 (5.15)	0.95 (1.81)	3.70 (3.95)	10.18 (15.48)	7.10 (7.10)	8.90 (10.96)	8.24 (7.83)	14.62 (18.44)	9.35 (6.02)
Types	0.50 (1.14)	1.22 (2.29)	0.77 (1.54)	2.83 (2.99)	3.68 (3.62)	3.48 (2.89)	5.67 (4.56)	5.52 (5.15)	6.81 (6.79)	5.30 (3.28)
CDI-Comp	9.36 (8.73)	8.50 (7.17)	20.10 (13.76)	22.23 (11.98)	29.70 (15.72)	37.76 (16.99)	43.80 (21.76)	42.85 (19.94)	56.81 (19.20)	61.95 (20.43)
CDI-Prod	1.00 (1.51)	0.65 (0.94)	3.50 (3.47)	2.61 (3.14)	8.45 (8.02)	6.29 (6.08)	12.35 (11.72)	12.76 (11.83)	25.00 (20.69)	31.11 (19.98)

Table 2

Series of regression models predicting children's MCDI vocabulary comprehension based on child age, intervention condition, parent mindsets and higher order interaction terms [95% Confidence Intervals]

	Model 1	Model 2	Model 3	Model 4
Fixed Effects				
Intercept (centered at 12 months)	22.00 (2.16)[17.73, 26.28]*	21.11 (3.15)[14.94, 27.28]*	20.30 (5.10)[10.32, 30.27]*	30.69 (7.34)[16.72, 44.67]*
Linear Growth (in months)	5.91 (0.24)[5.43, 6.39]*	5.70 (0.35)[5.02, 6.39]*	6.45 (0.58)[5.31, 7.59]*	7.84 (0.89)[6.10, 9.57]*
Condition		1.72 (4.36)[−6.80, 10.24]		−17.47 (9.60)[−35.75, 0.78]
Condition X Linear Growth		0.41 (0.49)[−0.55, 1.36]		−2.40 (1.16)[−4.66, −0.13]*
Mindsets			0.66 (1.99)[−3.22, 4.54]	−4.35 (2.88)[−9.83, 1.13]
Mindsets X Linear Growth			−0.20 (0.22)[−0.65, 0.24]	−0.84 (0.34)[−1.51, −0.17]*
Condition X Mindsets				8.51 (3.74)[1.38, 15.64]*
Condition X Mindsets X Linear				1.15 (0.45)[0.26, 2.03]*
Random Effects				
Intercept	12.87	12.99	13.02	11.92
Residual	10.13	10.14	10.17	10.01
Goodness of Fit (AIC)	1590.4	1593.3	1515.2	1507.8

*
Note.indicates confidence intervals that do not include 0

Table 3

Series of regression models predicting children's MCDI vocabulary production based on child age, intervention condition, parent mindsets and higher order interaction terms [95% Confidence Intervals]

	Model 1	Model 2	Model 3	Model 4	Model 5
Fixed Effects					
Intercept (centered at 12 months)	2.49 (1.25)[0.03, 4.93]*	3.13 (1.85)[−0.47, 6.72]	3.23 (2.92)[−2.46, 8.92]	5.59 (4.67)[−3.30, 14.48]	5.09 (4.57)[−3.60, 13.79]
Linear Growth (in months)	1.52 (0.36)[0.81, 2.23]*	1.50 (0.52)[0.48, 2.52]*	1.30 (0.89)[−0.43, 3.04]	2.84 (1.13)[0.66, 5.02]*	2.57 (0.83)[0.95, 4.19]*
Quadratic Growth (in months)	0.36 (0.08)[0.21, 0.51]*	0.26 (0.11)[0.05, 0.49]*	0.45 (0.19)[0.08, 0.82]*	0.30 (.22)[−1.11, 0.71]	0.38 (0.08)[0.22, 0.53]*
Condition		−1.17 (2.51)[−6.07, 3.74]		−3.48 (5.78)[−14.47, 7.52]	−2.48 (5.72)[−13.37, 8.41]
Condition × Linear Growth		0.06 (0.71)[−1.34 1.47]		−2.34 (1.17)[−4.60, −0.08]	−1.64 (0.99)[−3.57, 0.29]
Condition × Quadratic Growth		0.18 (0.15)[−0.12, 0.48]		0.18 (0.16)[−1.13, 0.49]	
Mindsets			−0.36 (1.14)[−2.59, 1.85]	−1.14 (1.79)[−4.56, 2.27]	−1.16 (1.76)[−4.51, 2.20]
Mindsets × Linear Growth			0.10 (0.34)[−0.58, 0.77]	−0.58 (0.42)[−1.39, 0.23]	−0.64 (0.30)[−1.22, −0.06]
Mindsets × Quadratic Growth			−0.04 (0.07)[−0.19, 0.10]	−0.01 (0.07)[−0.15, 0.13]	
Condition × Mindsets				1.04 (2.22)[−3.19, 5.28]	1.01 (2.23)[−3.23, 5.26]
Condition × Mindsets × Linear				1.03 (0.39)[0.28, 1.78]*	1.04 (0.39)[0.29, 1.79]*
Random Effects					
Intercept	6.23	6.34	6.06	6.15	6.17
Residual	8.48	8.40	8.66	8.40	8.38
Goodness of Fit (AIC)	1505.3	1506.2	1439.5	1435.4	1432.8

** Note.*indicates confidence intervals that do not include 0

Table 4

A series of regression models examining moderation effects of maternal education and intelligence mindsets on parent and child pointing outcomes with [95% Confidence Intervals]

	Parent Pointing Tokens		Parent Pointing Vocabulary		Child Pointing Tokens		Child Pointing Vocabulary	
	Model 1	**Model 2**	**Model 3**	**Model 4**	**Model 5**	**Model 6**	**Model 7**	**Model 8**
Baseline Pointing	0.50 * [0.005, 0.99]	0.31 [−0.20, 0.82]	0.49~ [−.03, 1.02]	0.38 [−0.15, 0.91]	0.42 *** [0.19, 0.65]	0.36 ** [0.13, 0.59]	0.79 *** [.41, 1.17]	0.65 *** [.27, 1.03]
Condition	8.80 [−9.11, 26.71]	12.52 * [1.06, 23.99]	3.22 [−3.78, 10.22]	5.15 * [0.56, 9.74]	1.51 [−1.10, 4.11]	1.98 * [0.24, 3.72]	0.98 [−.98, 2.94]	1.27 * [−.001, 2.54]
Education	0.17 [−3.86, 4.19]		−0.16 * [−1.76, 1.45]		−0.50 [−0.62, 0.52]		−0.10 [−.53, 0.33]	
Mindset		−7.07~ [−15.55, 1.41]		−2.31 [−5.62, 1.00]		−0.28 [−1.50, 0.93]		−0.32 [−1.19, 0.55]
ConditionXEducation	8.56 [−15.51, 32.63]		3.84 [−5.67, 13.35]		0.95 [−2.50, 4.38]		0.50 [−2.10, 3.08]	
ConditionXMindset		11.82 * [0.77, 22.86]		3.08 [−1.21, 7.38]		1.09 [−0.51, 2.69]		1.21 * [0.06, 2.35]
R^2 (%)	20.5	26.6	18.5	21.7	38.9	41.4	42.1	49.7

~ $p < .10$;

* $p < .05$;

** $p < .01$;

*** $p < .001$