Parents' Decontextualized Talk During Early Childhood Predicts the Neural Basis of Narrative Processing in Later Childhood

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Abstract: Early parental language input strongly predicts children's language development and academic success. Little is known about relations between early input and the neurobiology of language. Among different measures of input, parents' decontextualized utterances about abstract topics predict children's language outcomes more strongly than parental socioeconomic status and input quantity. Here, using fMRI, we show that preschool parental language input is associated with school-aged children recruiting different neurocognitive systems for language processing.

Introduction

Children are expected to converse in *academic language* once they arrive school. This language is used to tell a story, to make an argument, to comprehend a text, to give a presentation, to integrate information across multiple passages, etc. (Snow, 2010). Academic language is dense, abstract, and decontextualized. Thus, it presents distinct challenges from the conversational language that young children are typically exposed to in their daily lives. Other types of linguistic input must help prepare children for the challenges of academic language. We argue that early decontextualized language parents provide is just this type of input. Decontextualized language include talk about the past and future (e.g. Mom is going to go to the foot doctor tomorrow), pretend play talk (e.g. Come on horsies, gallop back to your stall), and explanations (e.g. Yes, let's turn the blocks so you can see the patterns on them). Here we ask whether children's early home environments vary in the opportunities to hear decontextualized language and, if so, whether parental decontextualized language input predicts the neurocognitive basis of children's language processing during school years.

Prior literature highlights strong relations between environmental factors, specifically parental socioeconomic status (SES), and *brain structure*. However, little is known about how the *neurofunctional basis* of academic performance varies as a function of environmental factors. Further, SES is a composite construct. Which component of SES is most strongly relates to neural differences is unknown (Hackman & Farah, 2009). Parental input might be a more proximate measure of children's day-to-day experiences than SES. Here we leveraged a neuroimaging method, fMRI, to provide additional information about the underlying neural processes that contribute to behavioral performance as children are engaged in a task. Specifically, we asked whether as a function of early parental decontextualized input, children recruit similar neural systems but with varying degrees of efficiency or they recruit different systems during a decontextualized language task – namely narrative processing.

Methods

Participants. Seventeen typically developing children and their parents participated in the study. Children and parents were drawn from a larger, monolingual sample participating in a longitudinal study of children's language development in the greater Chicago area. Children were 14 months at the time of their first visit, and were visited in their homes every four months after that point. To be included in the current analysis, the dyad needed to have the relevant home visit at 30 months and participated in the neuroimaging study at age 7-9 years. The children interacted at home with their primary caregiver. The average income for the sample was \$59,322 (*SD* = 3,294). The average years of education for the primary caregiver was 16 (*SD* = 2) years, corresponding to a Bachelor's degree.

Behavioral procedure. Parental input measure was based on parent-child interactions. Parents were asked to interact with their children as they normally would, and parent-child dyads were videotaped for a 90 minute period. All parent and child speech in the videotaped session at child age 30 months was transcribed (percent agreement 95%). Decontextualized language utterances produced by parents and children were identified (percent agreement 96%, Cohen's kappa 0.73). All utterances that were not coded as decontextualized were considered contextualized.

Neuroimaging procedure. Neuroimaging measures were collected when children entered school. When children were 7-9 years old, we administered a narrative comprehension task in a scanner using fMRI. Children passively viewed a storyteller narrating a story. When children came out of the scanner, they were asked comprehension questions about the stories they heard. Using partial least squares analysis (McIntosh & Lobaugh, 2004), we examined which brain networks show activation that covaries with early parental decontextualized input at the whole brain level.

Results

We found two networks in the brain that were related to the decontextualized input children received. The first network was positively related to input - that is the higher was the amount of decontextualized talk children received at 2.5 years of age, the higher was the recruitment of bilateral middle and superior temporal cortices (LV1, p = .02, Figure 1a). The second network was negatively related to input - the lower was the amount of decontextualized input, the higher was the recruitment of bilateral superior/inferior parietal, premotor cortices, and angular gyrus (LV1, p = .02, Figure 1b. No significant relations between neural activation in these clusters and parental SES or contextualized input were observed ($p > .10$). Parental input did not correlate with performance on comprehension questions ($p > .10$).

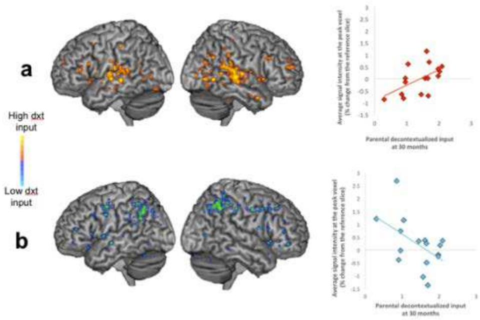

Figure 1. a) Brain networks that show a positive correlation (red) with parental decontextualized input. The singular image showing reliable clusters was mapped to the atlas and thresholded to show bootstrap ratios ≥ |+/-3| and number of nodes over 20. Scatterplot shows the relation between input and average signal intensity at the peak voxel of the network. b) Brain networks that show a negative correlation (blue) with parental decontextualized input. The singular image showing reliable clusters was mapped to the atlas and thresholded to show bootstrap ratios ≥ |+/-3| and number of nodes over 20. Scatterplot shows the relation between input and average signal intensity at the peak voxel of the network.

Discussion

Prior work established relations between parental SES and brain structures. However, not much is known about the relations between environmental factors and the neurofunctional basis of children's academic performance. Further, which aspect of SES most strongly predicts differences in brain function is also not known. We focused on parental language input and its relations to neural basis of narrative processing. In narrative processing, temporal areas are involved in verbal, semantic processing, whereas the parietal regions are involved in visuo-spatial mental building. Although correlational, results suggest that children respond adaptively to their early environments by relying on different neural systems to succeed at narrative processing. Our results suggested that children who are exposed to decontextualized language to a greater degree early in life rely on verbal, semantic networks in narrative processing, whereas children who heard decontextualized input to a lesser extent recruited visuospatial networks instead. Importantly, the two groups did not show behavioral differences. Although neuroscience's role in education research remains highly debated, we show that neuroimaging methods has the potential to reveal whether children might reveal different systems in the brain even when their behavioral performance is the same. This finding might have implications for interventions aiming to close the achievement gap. Children might need interventions that target different neural systems depending on input history.

References

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