Relations Between Early and Later Domain-Specific Higher-Order Thinking

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Higher-Order Thinking Talk

What is higher-order thinking talk (HOTT)?

- Language explicitly builds and connects representations, expressing reasoning *with* and *about* relationships
- Four types of linguistic devices: Inference, Comparison, Abstraction, Hierarchy (Frausel et al., under review)
- Can be surface (more perceptual) or structure (more complex) (Richland & Simms, 2015)

Why does early HOTT matter?

- *Necessary for academic success:* allows students to make connections, develop understanding of new materials, solve problems, and engage in generative thinking (Frausel et al., under review)
- *Separate from domain-specific knowledge:* a set of relational structures can be transposed across domains and can draw connections between them
- Children's HOTT production varies widely at school entry, and disparities in early HOTT influence later reasoning outcomes (Freeman, 2015)

Despite opportunities for HOTT to cut across domains, parents' speech input may encourage children's HOTT in some domains more than others

Research Questions

1. Are some domains (e.g. math, science, social) more likely to encourage use of parent-child HOTT than others?
2. Does early spontaneous use of HOTT in specific domains predict child HOTT later in development?

Method

Participants

- 50 typically-developing children and their parents, as part of a larger longitudinal study of language
- Families recruited to be representative of Chicago's monolingual English-speaking population (2000 Census); families from diverse racial, ethnic, economic, and educational backgrounds

Materials & Procedure

- Participants were visited in their homes every 4 months (12 sessions) between 14 and 58 months of age
  - Families were video recorded for 90 minutes of unguided interaction at each home visit
- At age 11 years, the same children and parents were visited in their homes
  - Parent-child dyads were video recorded cooperatively completing tasks designed to elicit HOTT in math, science, and social domains
- All parent and child speech was transcribed and coded for HOTT type and complexity at the utterance level
- At 50 months, HOTT in spontaneous interaction was coded by language domain

REFERENCES:
Frausel, et al. (under review). The origins of higher-order thinking lie in children's spontaneous talk across the preschool years.
Freeman, C. (2015). The effect of parental input on the development of higher order thinking in young children. (Doctoral dissertation, University of Chicago)
Richland, L. E., & Simms, N. (2015). Analogy, higher order thinking, and education. *Wiley Interdisciplinary Reviews: Cognitive Science*, *6*(2), 177-192.

Method

Types of HOTT Relational Language

- **Inference**: Deriving a conclusion not otherwise given by using known (or logical) premises
- **Comparison**: Demonstrating similarities or differences between entities by analogy or by example
- **Abstraction**: Pointing out mental frameworks or models that could facilitate thinking; making definitions that attempt to describe the meaning of a word or concept, beyond giving a label
- **Hierarchy:** An arrangement of categories with a superordinate/subordinate framework; relations between parts and wholes

Domains and Examples of Higher-Order Thinking Talk

	50 Mo.: Spontaneous Talk	11 Years: Parent-Child HOT Tasks	
Domain	HOTT Example	Example Task	Example HOTT
Math	"Try to make all the circles the same size as this one." (Comparison)	Use dice or paper and pencil to solve a probability problem	"Two-sixths would be a better chance." (Comparison)
Science	"Do you remember what kind of butterfly he'll be when he comes out?" (Hierarchy)	Discuss and diagram how light moves through water using a flashlight, pencil, and water bottle	"If I shine the light through the water, is it showing up on my sleeve?" (Inference)
Social	"Even though it's an accident you need to say 'I'm sorry'." (Abstraction)	Argue for or against a policy requiring all students to take the same classes	"What do you think every adult in America should know how to do?" (Abstraction)

Results

Distribution of HOTT by Domain

1. No significant differences in the distribution of HOTT by domain for either parents or children in early childhood.
2. At age 11, children and their parents both produced significantly more HOTT in the social domain than either the math or science domain.
3. Predictably, parents produce more HOTT than children. Although HOTT is an essential part of adult speech, these relational structures are challenging for children and are still developing in the school-age years.

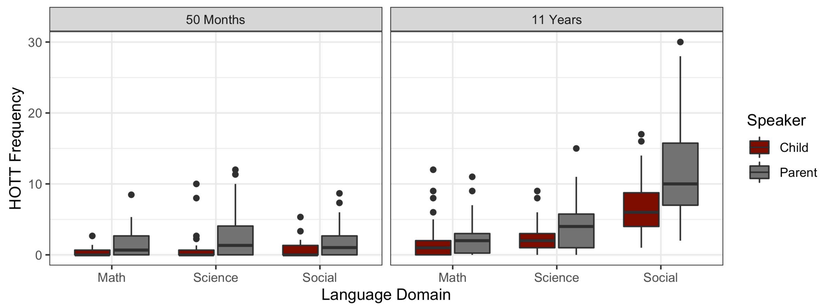

Figure 1. *Frequency distributions of parent and child HOTT in each domain. At 50 months, frequency is measured as HOTT utterances per hour; at 11 years HOTT frequency is measured at the total number of HOTT utterances in 3 5-minute tasks for each domain.*

Results

Early HOTT Predicting Later HOTT

1. Overall HOTT input in early childhood predicts later HOTT production in the science and social domains, and overall, but not in the math domain.
2. Early HOTT input in the social and math domains are not predictive of later HOTT production in those domains. There is a moderate correlation between early HOTT input in the science domain and later HOTT production during science tasks. Children's early HOTT is not predictive of their later HOTT use.

50 Mo. Spontaneous Talk		11 Years: Parent-Child HOT Tasks, Child HOTT			
Domain	Speaker	Math	Science	Social	All Domains
All Domains	Parent	*0.155*	0.394**	0.285*	0.304*
	Child	*0.213*	0.297*	*0.195*	*0.241*
Math	Parent	*0.010*			*0.260*
	Child	*-0.043*			*0.051*
Science	Parent		0.382**		0.290*
	Child		*0.148*		*0.053*
Social	Parent			*0.103*	*0.081*
	Child			*0.122*	*0.075*

Table 1. *Kendall's tau correlations across parents' and children's HOTT in the pre-school years and children's HOTT at age 11. * p < .05. ** p < .01: n = 50 dvads*

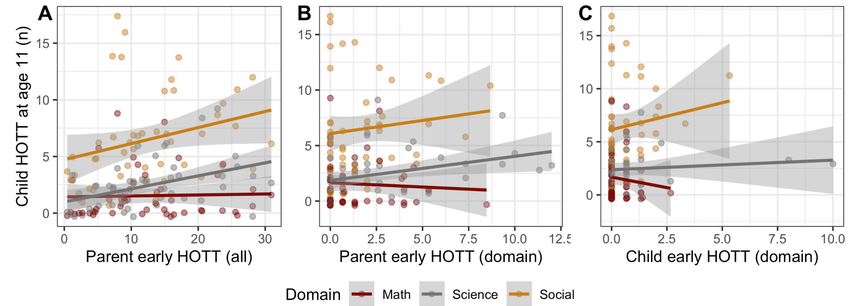

Figure 2. *Early HOTT measures to child HOTT in tasks at 11 yrs. (A) Overall parent HOTT input predicts child science and social HOTT, but not math. (B) Parent HOTT input in the science domain predicts child science HOTT (not math or social). (C) Child early HOTT does not predict their later HOTT in any domain (or overall - not shown).*

Conclusions

- Higher-order thinking involves a set of relational skills generalized beyond any particular domain of knowledge. Our results suggest early parent HOTT - regardless of domain - encourages the development of these relational concepts. While early parent HOTT input relates to later child HOTT outcomes, early child HOTT production does not, demonstrating both that HOTT ability is not an immutable trait and that parents may have a key role to play in the development of higher-order thinking skills.

- At age 11, children produced relatively little HOTT in math tasks, unrelated to parents' overall HOTT input, math HOTT input, or children's early math HOTT use. It may be that the language of mathematical relationships is highly dependent on the domain-specific knowledge acquired in the school-age years. If so, children may benefit from math instruction that explicitly translates the relational reasoning skills they already possess into the language and practices of classroom mathematics. Future work should look closely at the potential impact teachers have on relational reasoning language in academic domains like math.

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