Young Children's Learning of Mathematics from Male and Female Intelligent Media Characters

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Introduction

- Early math skills are foundational for children's academic achievement.[1]
  - The add-1 rule, knowing that adding one to a number increases the total sum by a single unit (e.g., 2 + 1 = 3) facilitates mastery of complex math tasks.[2]
- Girls and boys demonstrate similar basic numerical competencies,[3] but STEM is often stereotyped as a *male* domain.[4]
  - Increasing interest and skills in STEM for *both* boys and girls in childhood may help to engage children in STEM domains.
- Gender schema theory suggests that children's engagement with STEM content may be increased if they consider it relevant to their gender.[5]
- Intelligent Characters can serve as effective 21st century mathematics teachers for children.[6]
  - Children have *parasocial interactions* with characters, where the character asks a question, pauses for a reply, and responds contingently.[7]
  - Children who engage in more math talk parasocial interactions with an Intelligent Character answered add-1 problems faster, indicating increased skill mastery.[8]

- **Purpose:** To examine how children perform on add-1 math problems when engaging in math talk interactions with a same- or opposite-sex Intelligent Media Character.

Hypotheses

- Children engaging in more math talk will answer add-1 problems faster, compared to children engaging in less math talk.

- Children engaging in more math talk with a same-sex Intelligent Character, compared to opposite-sex character, will answer add-1 problems faster.

Method

- 90 4-year-old children participated (M_{age} = 4.42 years, SD = .33, range 3.89 – 5.17; 49 girls, 41 boys)
- 2 (child sex: boy or girl) by 2 (Intelligent Character: male or female character) design
  - Children were randomly assigned to play the Intelligent Character math game with a same- or opposite-sex Intelligent Character.
- Wizard of Oz paradigm (person hiding behind a screen controlled a computer to answer child through the character) with 3 math rounds
- Parasocial Interactions: Math talk scores (i.e., on-task numerical answers to add-one problems) were calculated for each child.
- Character knowledge questions (i.e., recognition and recall of name) were asked and entered into the analyses as covariates.

Results

Table 1
OLS Regression Predicting Average Response Latency in Seconds for Add-One Problems

	Model 1	Model 2
IVs	B (SE)	B (SE)
Math Talk	-.81** (.11)	-.57** (.14)
Child-Character Sex Match * Math Talk	---	-.51** (.18)
Constant	20.24 (24.44)	14.02 (24.07)
Adjusted R^2	.42	.46
F	14.01**	19.89**
df	4, 84	5, 83
N	89	89

*$p \le 0.05$; ** $p \le 0.01$; Robust Standard Errors
Note: Excludes 1 child who did not answer control variable character knowledge question and 22 children additional children who demonstrated ceiling level accuracy on the add-1 rule by answering all math problems correctly on their first try.
Math Talk: Calculated by dividing the number of math talk prompts a child replied to by the number of math talk prompts that were available to a child. That proportion had the possibility to range from 0 – 1 and was then multiplied by 100. This variable is mean centered at 85.55.
Covariates: child-character sex match, character knowledge, age

- Model 1 revealed that for each additional percentage point higher children scored on math talk, they answered add-1 problems .81 seconds faster ($p < .001$).
- Model 2 revealed that for each additional percentage point higher children scored on math talk with a sex-matched character, compared to an opposite-sex character, they answered add-1 problems .51 seconds faster ($p = .006$; See Figure 1).
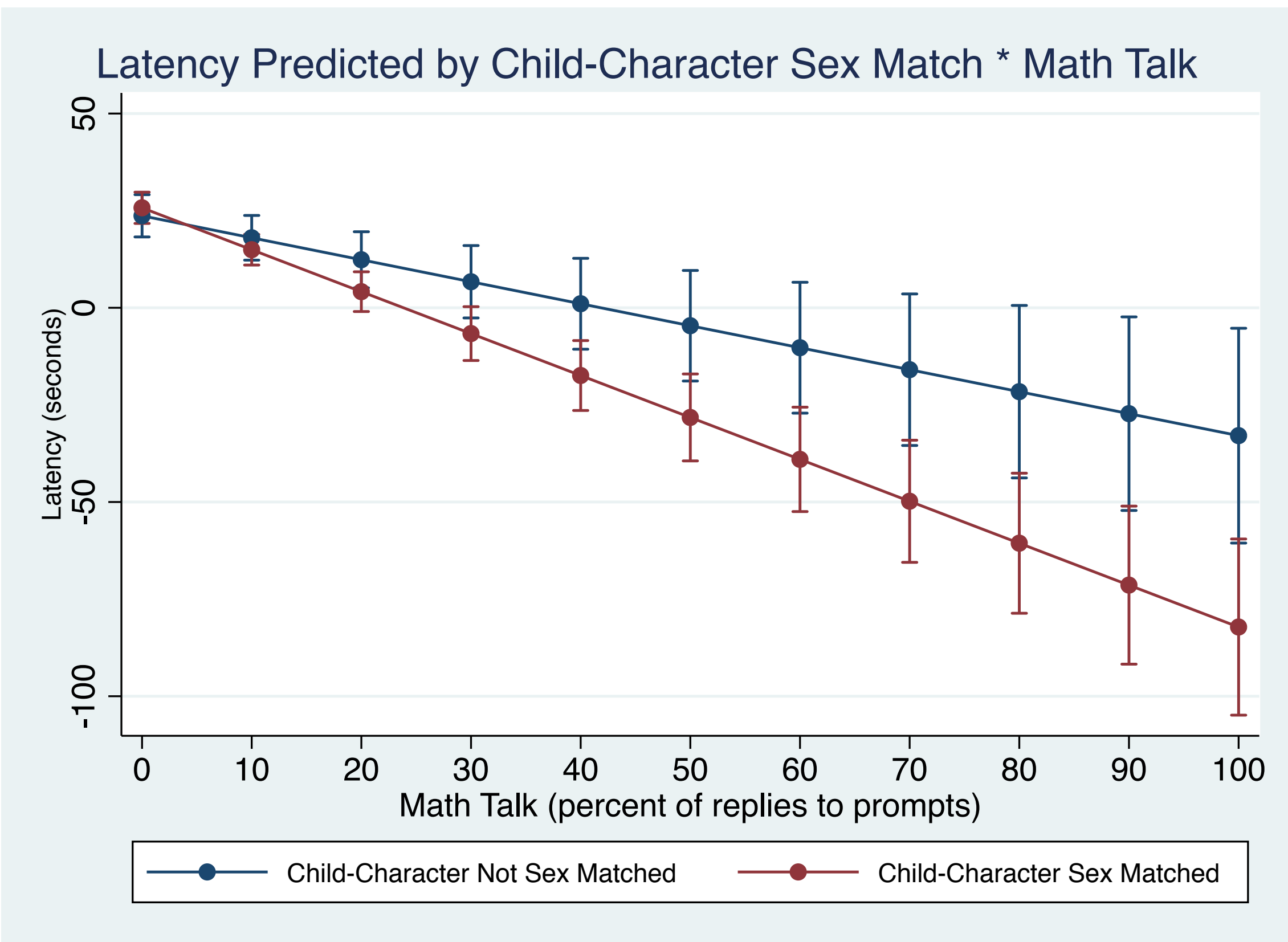

Figure 1. Graph of Interaction Term (Child-Character Sex Match * Math Talk) in Table 1

Discussion

- Consistent with previous research on Intelligent Characters teaching the add-1 rule,[8] higher amounts of math talk parasocial interactions resulted in quicker response times on the add-1 math problems.
- Children who engaged in math talk with a same-sex character demonstrated increased mastery of the add-1 rule, compared to an opposite-sex character.
- In line with gender schema theory, children may have viewed socially contingent interactions with a same-sex character as more relevant to themselves and were motivated to answer the math questions faster.
- Findings suggest that children demonstrate increased performance on early math skills when they interact contingently with a character who is similar to them in a visually salient way, in this case the same sex.
- Implication: Engaging in STEM content with characters can increase both girls' and boys' math outcomes when the character is the same-sex as the child.

References

1. Duncan et al. (2007); 2. Baroody (1985); 3. Hutchinson, Lyons, & Ansari (2018); 4. Leaper (2015); 5. Martin & Halverson (1981), Bem (1981); 6. Brunick et al. (2016); 7. Calvert, S.L. (2017); 8. Calvert et al. (2018).