Assessing associations between math talk and math performance: A preregistered meta-analysis

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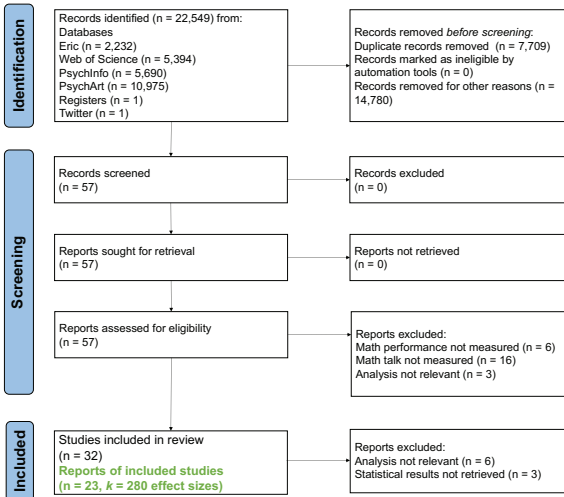[1]University of Pittsburgh, [2]University of California, Irvine

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OSF Preregistered Analysis: https://osf.io/fdw67

Do associations between parents' math talk and children's math performance reflect robust causal effects?

Identification of studies via databases and registers

Identification

Records identified (n = 22,549) from:
Databases
Eric (n = 2,232)
Web of Science (n = 5,394)
PsychInfo (n = 5,690)
PsychArt (n = 10,975)
Registers (n = 1)
Twitter (n = 1)

Records removed before screening:
Duplicate records removed (n = 7,709)
Records marked as ineligible by automation tools (n = 0)
Records removed for other reasons (n = 14,780)

Screening

Records screened (n = 57) → Records excluded (n = 0)

Reports sought for retrieval (n = 57) → Reports not retrieved (n = 0)

Reports assessed for eligibility (n = 57) → Reports excluded:
Math performance not measured (n = 6)
Math talk not measured (n = 16)
Analysis not relevant (n = 3)

Included

Studies included in review (n = 32)
Reports of included studies (n = 23, k = 280 effect sizes)

Reports excluded:
Analysis not relevant (n = 6)
Statistical results not retrieved (n = 3)

Author	Participating Caregiver	Math Talk Observation Context	Math Talk Observation Activity Structure	Math Talk Type	Math Talk Unit Level	Math Talk Variable	Math Outcome Type	Math Outcome Activity Structure	Number of Effect Sizes
Casey et al. (2018)	Only Mothers	Lab	Semi-Structured	Number	Utterance	Log-Transformed Raw Frequency	Number	Standardized Assessment	22
Casey et al. (2020)	Only Mothers	Home	Structured	Number	Other	Proportion Score	Number	Experimenter Assessment	16
DePascale et al. (2021)	Mostly Mothers	Lab	Semi-Structured	Number	Utterance	Raw Frequency	Number	Standardized Assessment	9
Duong et al. (2021)	Mostly Mothers	Home	Structured	Combined	Utterance	Raw Frequency	Number, Spatial, and Combined	Standardized Assessment and Experimenter Assessment	12
Elliott et al. (2017)	Only Mothers	Lab	Semi-Structured	Number	Word	Proportion Score	Number	Standardized Assessment	10
Gunderson & Levine (2011)	Not Reported	Home	Unstructured	Number	Utterance	Log-Transformed Raw Frequency	Number	Experimenter Assessment	11
Gürgah Ogul & Aktas Ars (2021)	Only Mothers	Home	Unstructured	Combined	Word	Proportion Score	Number	Standardized Assessment	2
Lehrl et al. (2020)	Mostly Mothers	School	Semi-Structured	Combined	Other	Other	Number and Combined	Standardized Assessment	6
Levine et al. (2010)	Mostly Mothers	Home	Unstructured	Number	Word	Log-Transformed Raw Frequency	Number	Experimenter Assessment	5
Leyva (2019)	Mostly Mothers	School	Structured	Number	Utterance	Proportion Score	Number	Standardized Assessment	1
Lombardi et al. (2017)	Only Mothers	Lab	Semi-Structured	Number	Number and Spatial	Other	Other	Number	Standardized Assessment	13
Mutaf Yildiz et al. (2018)	Mostly Mothers	Home	Semi-Structured	Number	Utterance	Raw Frequency	Number	Standardized Assessment	2
Pruden et al. (2011)	Mostly Mothers	Home	Unstructured	Spatial	Word	Raw Frequency	Spatial	Standardized Assessment	11
Ramani et al. (2015)	Mostly Mothers	School	Semi-Structured	Number	Utterance	Proportion Score	Number	Experimenter Assessment	20
Ren et al. (2022)	Both Parents, Only Fathers, and Only Mothers	Home and Lab	Semi-Structured	Spatial	Word	Log-Transformed Raw Frequency	Number and Spatial	Standardized Assessment	20
Ribeiro et al. (2020)	Only Mothers	Other	Structured	Spatial	Other	Other	Number and Combined	Standardized Assessment and Other	12
Silver et al. (2021)	Mostly Mothers	Lab	Semi-Structured	Number	Word	Raw Frequency	Number	Standardized Assessment	3
Silver et al. (2022)	Mostly Mothers	Lab	Semi-Structured	Number	Word	Raw Frequency	Number	Standardized Assessment	3
Son & Hur (2020)	Mostly Mothers	Home	Structured	Number	Utterance	Raw Frequency	Number	Standardized Assessment	25
Susperreguy & Davis-Kean (2016)	Only Mothers	Home	Unstructured	Number	Utterance	Proportion Score	Number	Standardized Assessment	2
Thippanna et al. (2020)	Mostly Mothers	Home and Lab	Semi-Structured and Unstructured	Number	Word	Proportion Score	Number	Standardized Assessment	4
Thomson et al. (2020)	Only Fathers	Home	Semi-Structured	Spatial	Word	Raw Frequency	Number	Standardized Assessment	4
Trickett et al. (2022)	Mostly Mothers	Lab	Semi-Structured	Number	Utterance	Proportion Score	Number	Experimenter Assessment	87

Funnel plot of main model

Main Effect of Parents' Math Talk on Children's Math Performance Across Covariate Model Specifications

Associations Differ as a Function of:
(significant moderators shown in green and bolded)

Sample characteristics?
- **Child age at math talk measurement**
  - Association decreases 0.0045 (0.001) for each 1-month increase in mean child age
- Child age at math outcome measurement
- Time between math talk and math outcome measurement
- Family income
- Parent education
- **Participating caregiver**
  - Association is 0.27 (0.03) lower when only dads participated in contrast to both parents
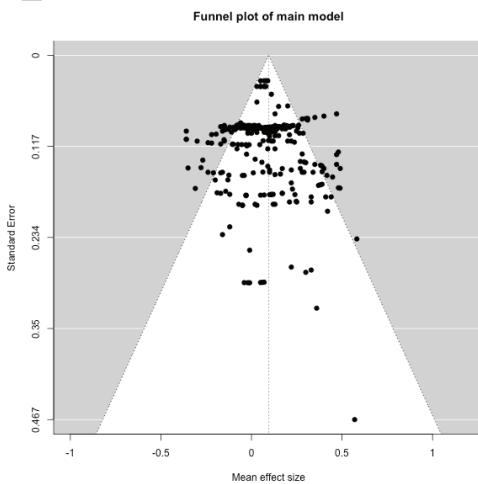
Math talk observation characteristics?
- Math talk observation context
- **Math talk observation activity structure**
  - Association is 0.23 (0.06) higher with unstructured in contrast to semi-structured activities
- **Math talk observation length**
  - Association increases 0.0004 (0.0001) for each 1-minute increase in mean observation length
- Math talk type
- Math talk unit level
- **Math talk variable modeling approach**
  - Association is 0.12 (0.08) lower with raw frequency in contrast to log-transformed variables
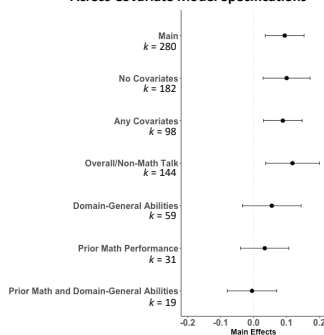
Math outcome characteristics?
- Math outcome type
- Math outcome activity structure
- Math outcome variable modeling approach

Overall modeling?
- Modeling approach
- Math talk and math outcome type match
- **Level of covariate control**
  - Association is lower when controlling for domain-general and/or prior math abilities

Parents' math talk significantly predicts children's math performance
b (SE) = 0.10 (0.03), p = .0016
even when controlling for overall/non-math talk,
but effects are attenuated when controlling for cognitive abilities