

Publication bias inflates effect size estimates for common educational interventions

Educational policies research group

Research team

Bastian BETTHAEUSER

Principal Investigator & Project Lead
Assistant Professor of Sociology,
Centre for Research on Social Inequalities (CRIS), Sciences Po, Paris, France

Bartholomew A. KONECHNI

Postdoctoral Researcher, Centre for Research on Social Inequalities (CRIS), Sciences Po, Paris, France

Susan SWINGLER

Doctoral Researcher, Department of Social Policy and Policy Evaluation, Oxford University, Oxford, United Kingdom

Vanessa WITTEMANN

Postdoctoral Researcher, Centre for Research on Social Inequalities (CRIS), Sciences Po, Paris, France

Anders M.

BACH-MORTENSEN

Assistant Professor, Department of Social Sciences and Business, Roskilde University, Roskilde, Denmark

Gaia GRASSI

Predocctoral Researcher, Centre for Research on Social Inequalities (CRIS), Sciences Po, Paris, France

Niklas AYRIS

Doctoral Researcher, Centre for Research on Social Inequalities (CRIS), Sciences Po, Paris, France

Una OLJACA

Former Predocctoral Researcher, Centre for Research on Social Inequalities (CRIS), Sciences Po, Paris, France

Funded by a public grant overseen by the French National Research Agency (ANR) as part of the "Investissements d'Avenir" program LIEPP (ANR-11-LABX-0091, ANR-11-IDEX-0005-02) and the Université de Paris IdEx (ANR-18-IDEX-0001) and the European Union (ERC, LEARN, 101163266). Views and opinions expressed are, however, those of the authors only and do not necessarily reflect those of the European Union or the European Research Council. Neither the European Union nor the granting authority can be held responsible for them.

Background

Supplementary learning interventions – education programs that extend or happen outside of class time – have become a major preoccupation of education actors.

Yet meta-studies remain limited because they: (i) don't compare different interventions, (ii) lack quality appraisal of underlying estimates (iii) pay insufficient attention to publication bias.

We conduct a meta-study comparing four interventions: (1) after school programs, (2) extended instruction, (3) tutoring, and (4) summer programs.

Building Our Meta Database

To be included studies must:

- Study 1 of the 4 interventions (not in class time).
- Use a causal research design.
- Report learning in terms of Cohen's *d*.

We also assessed all studies using ROBIN's-I, excluding critical and serious papers.

This left 194 estimates from 57 studies, across 18 countries. But 78% of estimates in Global North

Evidence of Publication Bias

Publication bias occurs when significant results are more likely to be released.

On the left, we show the z-score distribution. If there were no publication bias, the density of estimates should evolve smoothly, following the normal distribution (see the red line).

Instead, we see a sudden jump in the number of estimates just after the conventional line of significance ($z = 1.96$). This is evidence of publication bias.

The finding of publication bias suggests that existing meta-analyses may overestimate the effectiveness of supplementary learning interventions. We correct for publication bias, using four state-of-the-art approaches, explained below.

Results and Big Takeaway

We estimate the average effect size for each intervention using a naïve random-effects model and 5 state-of-the-art techniques to correct for publication bias:

PET-PEESE	Control for SE (or SE^2)
3PSM	Adjusts for probability that an estimate is contained with bins of p-values.
RoBMA	Bayesian averaged ensemble of 36 different techniques.
MAIVE	Same as PET-PEESE, but uses sample size as an instrument for SE to account for p-hacking.
MAN	Excludes all affirmative results.

For unadjusted estimates, we find that tutoring is the most impactful intervention type [$d = 0.20$, 95% CI 0.12 to 0.27], then after school programs [$d = 0.17$, 95% CI 0.03 to 0.30], then summer programs [$d = 0.16$, 95% CI 0.06 to 0.27], last extended instruction [$d = 0.08$, 95% CI 0.05 to 0.11].

However, once we apply our correction techniques only tutoring remains consistently different from zero.

This doesn't mean that tutoring is the most effective, rather that it has the most robust evidence behind it. Our study shows how publication bias creates uncertainty in research.

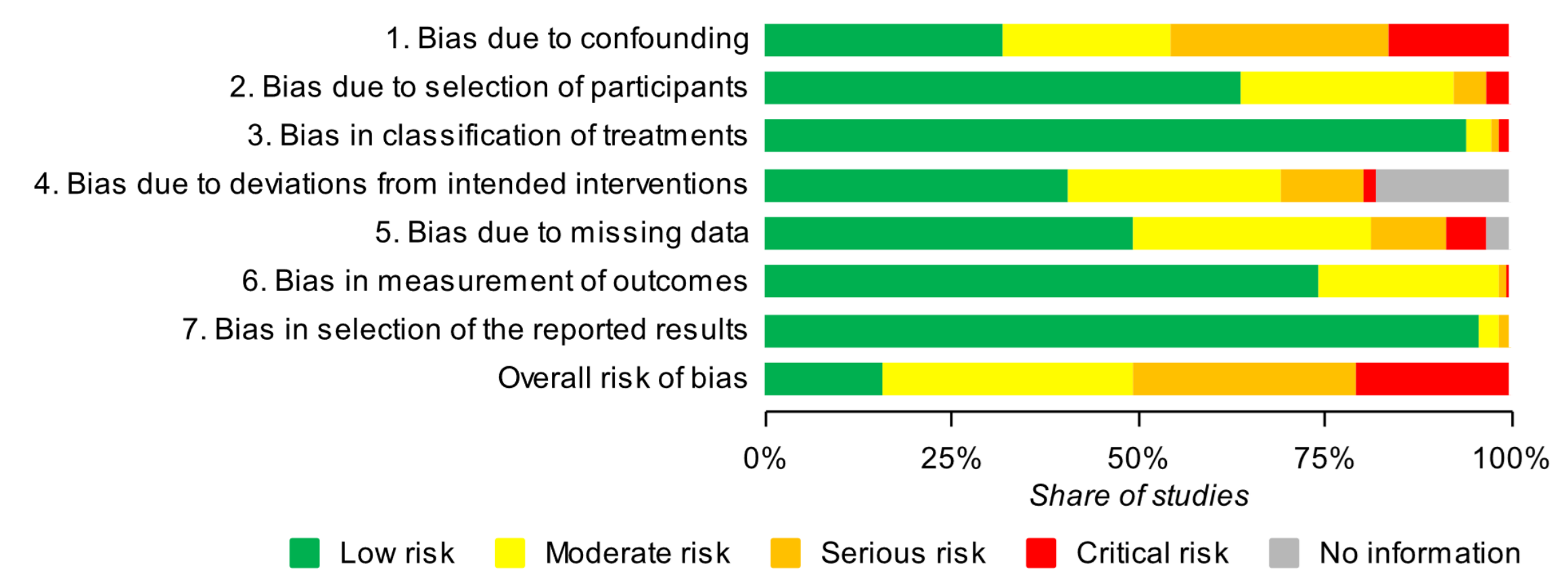


Figure 1: Distribution of studies of supplementary learning interventions by domain-specific and overall risk of bias rating, following ROBINs-I.

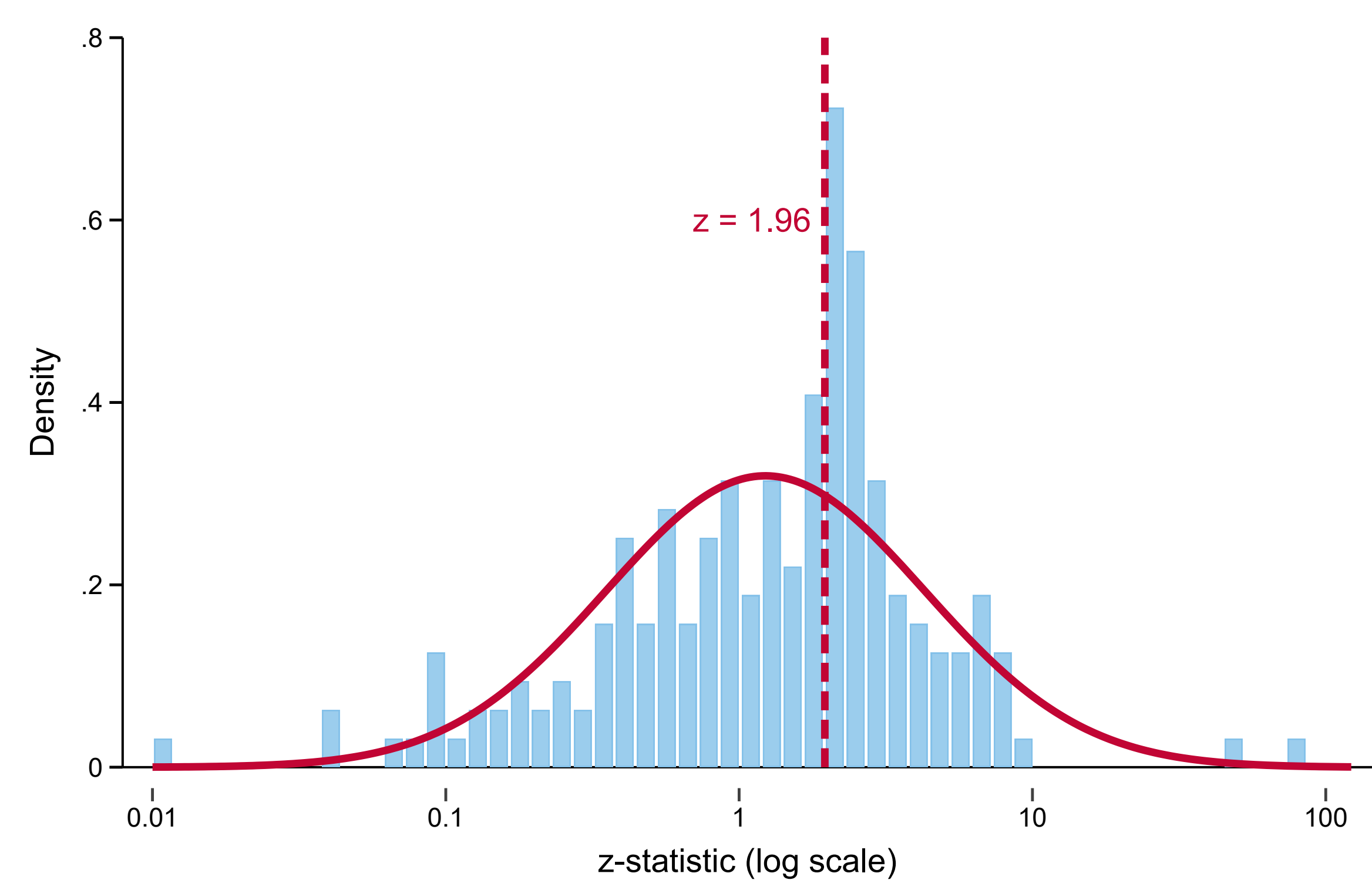


Figure 2: Z-curve from all estimates included in the meta-analysis.

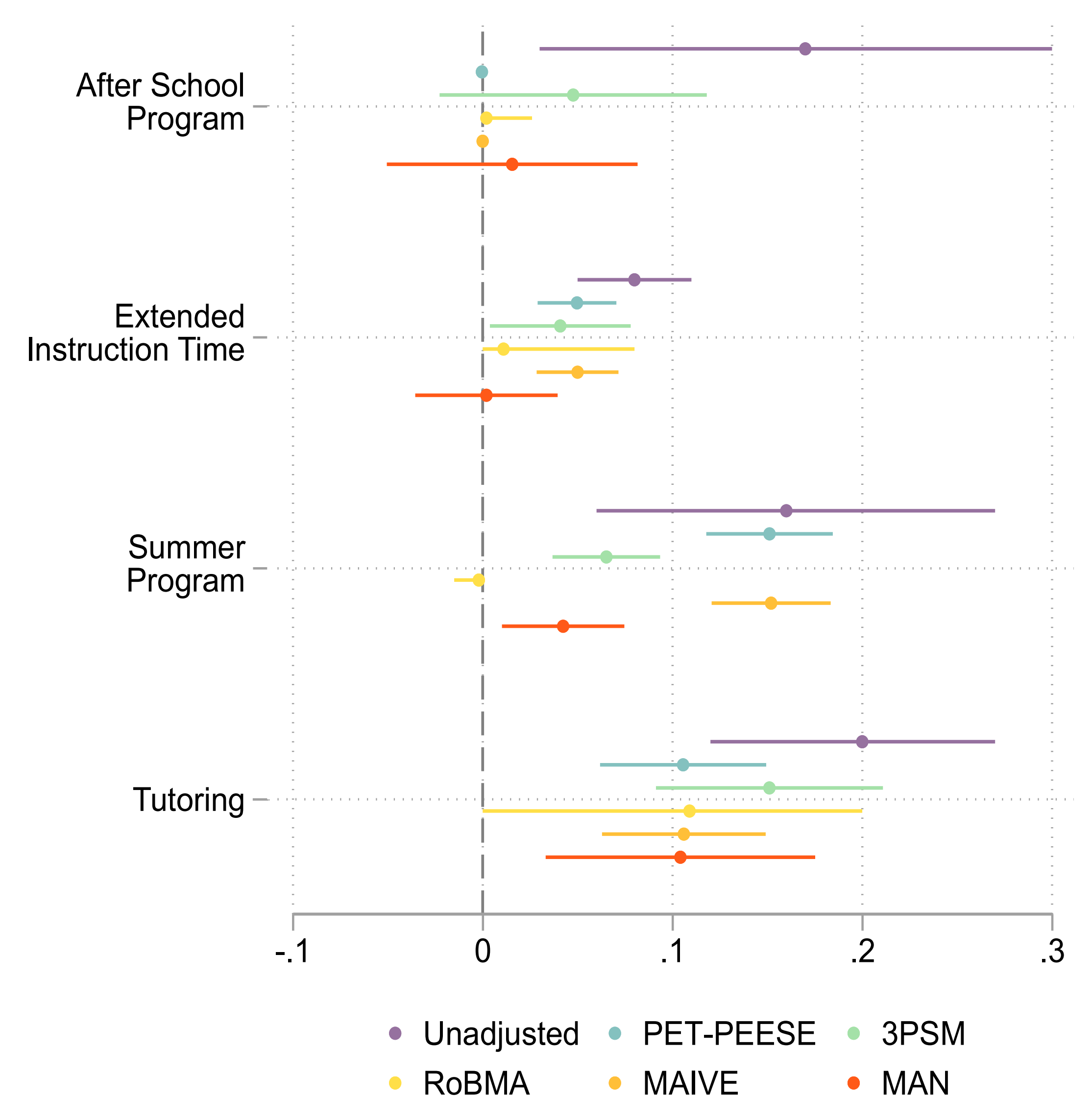


Figure 3: Effect sizes by type of intervention estimated using six alternative estimators (PET-PEESE, 3PSM, RoBMA, MAIVE, and MAN) with 95% confidence intervals.