

## **SECOND ENDLINE ANALYSIS: Every Child Counts**

### General Notes:

1. This document outlines our main tests regarding causal effects of the treatment at the second endpoint. We will also do complementary analysis to both describe and examine the channels/mechanisms through which children learn.
2. Practice trials are never included in any of these analyses.
3. Responses of “I don’t know”, “refuse to answer” or trials skipped due to actions of the child (such as crying) are coded as incorrect; trials are not scored if the child does not finish the test for reasons beyond their control (such as a computer failure).
4. Percentage of correct responses is calculated by dividing the number of correct trials by the number of trials given (i.e., correct/(correct + incorrect + I don't know + refuse to answer)). Trials that are not given due to circumstances beyond the child’s control do not enter into this calculation.
5. Z-scores are calculated by standardizing to the baseline control values where available and control group values in all other cases.
6. Throughout we use the following regression frameworks:

$$y_{i,j} = \text{math}_j + \text{social}_j + \text{age}_{i,j} + \text{gender}_{i,j} + \varepsilon_{i,j} \quad (1)$$

$$y_{i,j} = \text{math}_j + \text{social}_j + \text{age}_{i,j} + \text{gender}_{i,j} + \text{baseline}_{i,j} + \varepsilon_{i,j} \quad (2)$$

Where  $y_{i,j}$  represents the endpoint value of an outcome for child  $i$  in school  $j$ ,  $\text{math}_j$  is a indicator variable for whether school  $j$  was treated with the math games intervention,  $\text{social}_j$  is an indicator variable for whether school  $j$  was treated with the social games intervention,  $\text{age}_{i,j}$  is age in months of child  $i$  in school  $j$ ,  $\text{gender}_{i,j}$  is gender of child  $i$  in school  $j$ , and  $\text{baseline}_{i,j}$  is the baseline value of outcome  $y_{i,j}$  for child  $i$  in school  $j$ . Standard errors will be clustered at the school level.

### Overall Outcomes and Hypotheses:

- Main Outcome 1: Z-Score of percentage correct across all math tests (Geometric Intruder, Panamath, Point to a Number, Point to a Shape, Extra Number Questions, and Extra Geometry Questions)
- Hypothesis:
  - The math treatment will generate positive effects and the social treatment will generate smaller effects.
  - Due to varying similarity of the tests to the math intervention, treatment effects will be observed in the following descending order of likelihood:
    - Closest to intervention: Geometric Intruder
    - Next closest: Point to a Shape
    - Furthest: Extra Number Questions, Extra Geometry Questions, Point to a Number, and Panamath
- Test:

- Regress outcomes using (1) and (2), but because baseline values are not available for all tests, instead of  $\text{baseline}_{i,j}$  include an average of the Z-scores of the percentage correct on all number math tests at baseline (Point to Number and Panamath) and an average of the Z-scores of the percentage correct on all geometric math tests at baseline (Geometric Intruder and Point to Shape) to control for baseline level.
  - Calculate the difference in treatment effects estimated between endline one (EL1) and endline two (EL2) for a Z-score of percentage correct on all math tests common to both endlines (Geometric Intruder, Panamath, Point to a Number and Point to a Shape). We have no clear hypothesis; the treatment effects could have increased (if the gains experienced in non-symbolic skills facilitates further gains), decreased (if the effect decays without sustained intervention) or stayed the same, but the rate of decay or increase is of key interest.
- Main Outcome 2: Z-Score of percentage correct across all *non-symbolic* math tests (Geometric Intruder, Panamath)
  - Hypothesis:
    - The math treatment will generate positive effects and the social treatment will generate smaller effects.
  - Test:
    - Regress outcomes using (1) and (2)
    - Compare results with the same measure in EL1. We have no clear hypothesis; the treatment effects could have increased (if the gains experienced in non-symbolic skills facilitates further gains), decreased (if the effect decays without sustained intervention) or stayed the same, but the rate of decay or increase is of key interest.
- Main Outcome 3: Z-Score of percentage correct across all *symbolic* math tests (Point to a Number, Point to a Shape, Extra Number Questions, and Extra Geometry Questions)
  - Hypothesis:
    - The math treatment will generate positive effects and the social treatment will generate smaller effects.
  - Test:
    - Regress outcomes using (1). Regress outcomes using (2), but because baseline values are not available for all tests, instead of  $\text{baseline}_{i,j}$  include an average of the Z-scores of the percentage correct on all number math tests at baseline (Point to Number and Panamath) and an average of the Z-scores of the percentage correct on all geometric math tests at baseline (Geometric Intruder and Point to Shape) to control for baseline level.
    - Calculate the difference in treatment effects estimated between endline one (EL1) and endline two (EL2) for a Z-score of percentage correct on all symbolic math tests common to both endlines (Point to a Number and Point to a Shape). We have no clear hypothesis; the treatment effects could have increased (if the gains experienced in non-symbolic skills facilitates further gains), decreased (if the effect decays without sustained intervention) or stayed the same, but the rate of decay or increase is of key interest.

- Main Outcome 4: Percentage of correct responses on Gaze Intruder.
- Hypothesis:
  - The social treatment will generate positive effects and the math treatment will generate smaller effects.
- Test:
  - Regress outcomes using (1) and (2).
  - Compare results with the same measure in EL1. We have no clear hypothesis; the treatment effects could have increased (if the gains experienced in non-symbolic skills facilitates further gains), decreased (if the effect decays without sustained intervention) or stayed the same, but the rate of decay or increase is of key interest.

#### Test Specific Outcomes and Hypotheses:

Geometric Intruder: There are 3 practice trials and 12 test trials.

- Main outcome: Percentage of correct responses
- Hypothesis: This is the most direct test of the math treatment. The math intervention will generate positive effects and the social intervention will generate smaller effects.
- Test: Regress outcomes using (1) and (2). Then compare the estimated treatment effect with the one found in EL1,

Panamath: There are 2 practice trials and 10 test trials. Practice trials may be repeated either before each block (if children get them wrong) or in the middle of a block (if children persevere on one response side).

- Main outcome: Percentage of correct responses
- Hypothesis: The math intervention will generate positive effects and the social intervention will generate smaller effects.
- Test: Regress outcomes using (1) and (2). Then compare the estimated treatment effect with the one found in EL1,

Point to a Number: There is 1 practice trial and 9 test trials.

- Main outcome: Percentage of correct responses
- Hypothesis: The math intervention will generate positive effects and the social intervention will generate smaller effects.
- Test: Regress outcomes using (1) and (2). Then compare the estimated treatment effect with the one found in EL1,

Point to a Shape: There is 1 practice trial and 9 test trials.

- Main outcome: Percentage of correct responses
- Hypothesis: The math intervention will generate positive effects and the social intervention will generate smaller effects.
- Test: Regress outcomes using (1) and (2). Then compare the estimated treatment effect with the one found in EL1,

Extra Number Questions: There are 3 practice trials and 12 test trials.

- Main outcome: Percentage of correct responses
- Other outcomes of interest:
  - Percentage of correct responses in comparison problems (Qs 1-4)
  - Percentage of correct responses in addition problems with answers in the form of a comparison. (Qs 5-8)
  - Percentage of correct responses in addition problems with open-ended answers (Qs 9-12)
- Hypothesis: The math intervention will generate positive effects and the social intervention will generate smaller effects. Because each subgroup of questions is most similar to one of the three number training games, the relative size of effects found in the subgroups of questions is uncertain.
- Test: Regress outcomes using (1). Regress outcomes using (2), but because baseline values are not available for this test, instead of  $\text{baseline}_{i,j}$  include an average of the Z-scores of the percentage correct on all number math tests at baseline (Point to Number and Panamath) to control for baseline level.

Extra Geometry Questions: There are 3 practice trials and 12 test trials.

- Main outcome: Percentage of correct responses
- Other outcomes of interest:
  - Percentage of correct responses in problems over sides and corners (Qs 1-4,11,12)
  - Percentage of correct responses in problems about shapes and lines (Qs 5-10)
- Hypothesis: The math intervention will generate positive effects and the social intervention will generate smaller effects. Because the problems in the second subgroup are more similar to both of the geometry training games, the effects will be larger in the subgroup of questions about shapes and lines.
- Test: Regress outcomes using (1). Regress outcomes using (2), but because baseline values are not available for this test, instead of  $\text{baseline}_{i,j}$  include an average of the Z-scores of the percentage correct on all geometric math tests at baseline (Geometric Intruder and Point to Shape) to control for baseline level.

Gaze Intruder: There are 3 practice trials and 6 test trials.

- Main outcome: Percentage of correct responses
- Hypothesis: This is the most direct test of the social treatment. The social intervention will generate positive effects and the math intervention will generate smaller effects
- Test: Regress outcomes using (1) and (2). Then compare the estimated treatment effect with the one found in EL1.

Point to an Emotion: There is 1 practice trial and 9 test trials.

- Main outcome: Percentage of correct responses
- Hypothesis: The social intervention will generate positive effects and the math intervention will generate smaller effects
- Test: Regress outcomes using (1). Regress outcomes using (2), but because baseline values are not available for this test, instead of  $\text{baseline}_{i,j}$  include the Z-score of the percentage correct on Gaze Intruder at baseline to control for baseline ability.

## Additional Outcomes and Hypotheses:

### Comparing Math and Social Treatment Effects:

- Main Outcome: Improvement from baseline of percentage correct on Geometric Intruder scaled by the mean improvement of the control group and improvement of percentage correct on Gaze Intruder scaled by the mean improvement of the control group.
- Hypothesis: The math intervention and the social intervention will generate equally sized effects.
- Test: Regress outcomes separately and test for equality of coefficients on  $math_j$  from the math regression and  $social_j$  from the social regression.

### Examining Heterogeneity in Treatment Effects:

- Main Outcome: Z-Score of percentage correct across all math tests examined by baseline executive function performance, baseline math test performance, age and school enrollment.
- Other Outcome of Interest: Z-Score of percentage correct across all *symbolic* math tests (Point to a Number, Point to a Shape, and Extra Number Questions, Extra Geometry Questions) examined by school enrollment.
- Hypotheses:
  - Students who performed better on the baseline executive function test will perform better and have larger treatment effects from the math intervention.
  - The relative sizes of treatment effects based on baseline math games scores and age are uncertain, but policy relevant.
  - Students with more exposure to school will have larger treatment effects on both measures and the difference will be larger on the symbolic math measures.
- Tests:
  - Regress the main outcome on an interaction of the treatment dummies with a Z-score of the difference between the percentage of correct answers between blocks 1 and 2 (response switching) and the difference between the percentage of correct answers between block groups 3-4 and 1-2 (task switching) and main effects.
  - Separate students at terciles of the Z-score of percentage correct across all math tests at baseline (Panamath, Point to Number, Point to Shape and Geometric Intruder) and regress the main outcome using (1) and (2).
  - Regress the main outcome on an interaction of the treatment dummies with age and main effects.
  - Examine if treatment is correlated with school enrollment. If not, regress both outcomes using (1) and (2) for the enrolled sample and the not enrolled sample.