Informal Math Games to Improve Children's Readiness for Learning School Mathematics in India

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Sector(s): Education

Location: New Delhi, India

Sample: 1540 children; randomization occurred across 214 preschools

Target group: Children Children under five Students Teachers

Outcome of interest: Student learning

Intervention type: Early childhood development

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Research Papers: Cognitive science in the field: A preschool intervention durably enhances intui...

Partner organization(s): Harvard University, Pratham, UBS Optimus Foundation

By the time they reach primary school, disadvantaged children often lag behind their more advantaged peers in the skills and concepts of formal math. To address this issue, researchers examined the impact of math games, played in preschools and exercising early emerging, universal and intuitive numerical and spatial abilities, on children's learning of school math in Delhi, India. They found that the games led to long-term increases in children's intuitive math abilities. The games also bolstered children's mastery of the spatial and numerical language used in the preschools, but they did not enhance children's subsequent learning of primary school mathematics.

Policy issue

Primary school enrollment and attendance rates in developing countries have increased substantially in recent decades, yet children's learning outcomes have not followed suit. Learning disparities begin early and can be hard to overcome. By primary school enrollment age, children from disadvantaged backgrounds often lag behind their wealthier peers.[1]

Preschool years offer an opportunity to support disadvantaged children's cognitive development, generate lasting effects on school performance, and close learning outcome gaps. Yet, there is little rigorous evidence on strategies to improve preschool teaching and learning quality. How can preschool activities help disadvantaged children develop, both in the short-term and long-term? To answer this question, researchers examined the impact of math games on preschool children's intuitive and formal math abilities in Delhi, India.

Context of the evaluation

For the 2013-2014 school year (when this evaluation took place), around 9 out of every 10 primary-school aged children in India were enrolled in school.[2] Despite this, learning outcomes remained poor. For example, 87 percent of second grade children and 52 percent of fifth grade children in India could not read second grade-level material.Pratham, the implementing partner for this evaluation, is an education-focused non-profit organization based in India that operates 2,300 preschool education centers across the country serving 50,000 children.[3] At the time of the intervention, Pratham operated approximately 300 preschools in low-income neighborhoods of Delhi. The children included in this evaluation were four- to five- years old and headed to primary school in the months following the intervention, with an even split between girls and boys.

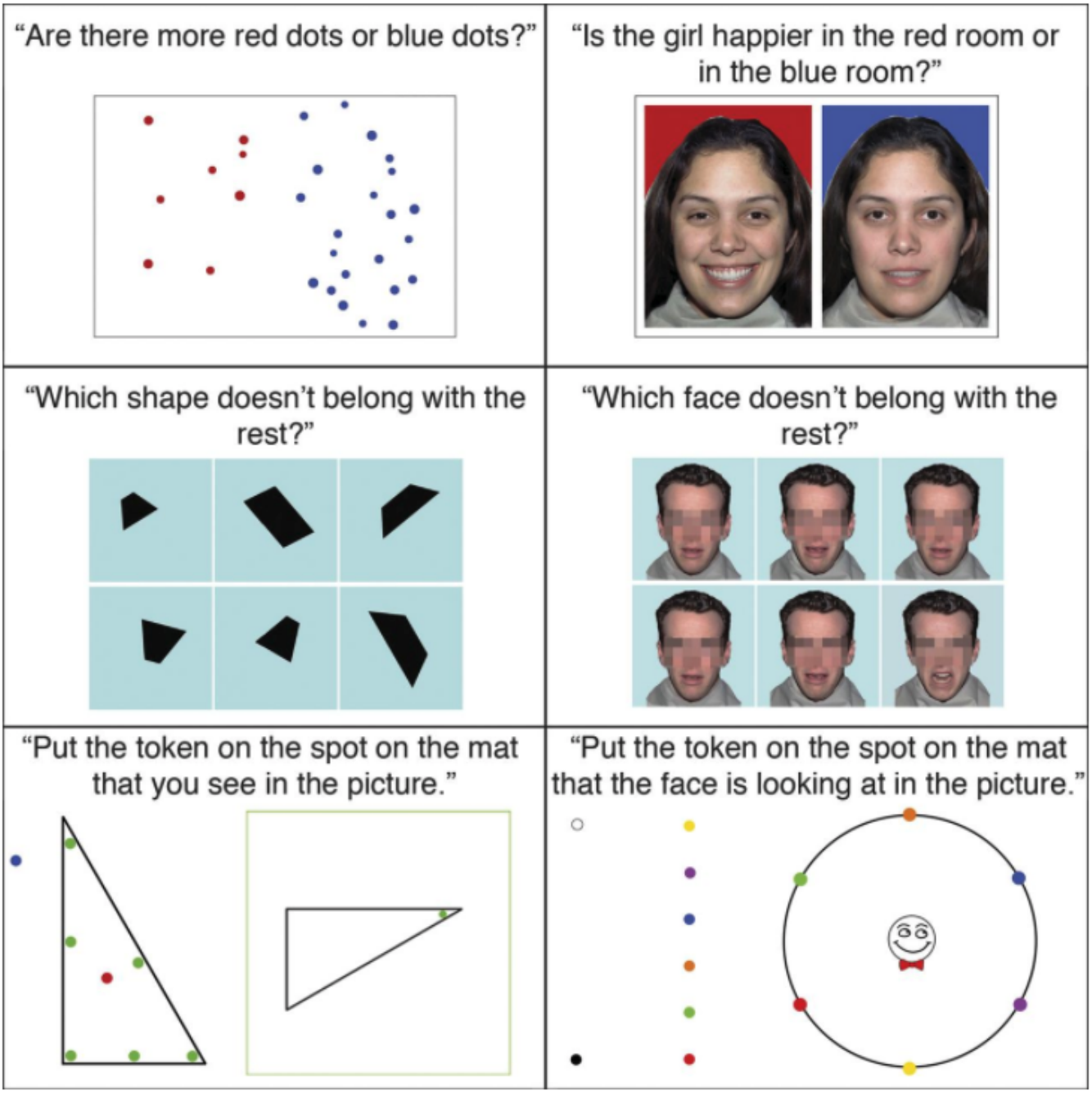

Figure 1. Examples of intuitive games designed to develop math (left column) or social abilities (right column).

Details of the intervention

Researchers partnered with Pratham to conduct a randomized evaluation to examine the impact of intuitive math games on preschool children's mastery of the language, symbols, and skills of preschool and primary school math in Delhi. Intuitive games were designed to exercise and enhance children's understanding of, and interest in, numbers and shapes; they did not train the formal math skills or terminology to be used in school.

Pratham identified 1,540 children across 214 Delhi preschools to participate in the study. Researchers randomly assigned preschools to one of three groups:

1. Math games treatment: students played games structured to develop their intuitive numerical and spatial abilities (see Figure 1). Basic research in cognitive science and early childhood development, conducted in controlled laboratory settings, informed the math games design.
2. Social games comparison: students played games similar in format and difficulty to the math games, but these games instead focused on intuitive and universal social skills relevant to school learning (see Figure 1). This comparison group allowed researchers to determine whether the games' content, rather than the simple act of playing challenging, intuitive games aimed to enhance children's learning, led to math gains.
3. No games comparison: students received Pratham's standard curriculum. Math-related content included memory games, sequences and matching, numerical and spatial language and concepts, and more.

During the four-month intervention, trained games facilitators led three one-hour sessions each week of either math games or social games in the two treatment conditions.

Researchers tested the students at four time points: before primary school started, after it ended (1-3 months after the intervention), midway through the first year of primary school (6-9 months after the intervention), and after one year of primary school (12-15 months after the intervention). The tests focused on the children's intuitive and symbolic math skills, as well as their language and social skills. Intuitive math skills included tasks such as comparing dot quantities and finding a different shape in a set of shapes. At the first two time points, symbolic math tests focused on the spatial and numerical language, symbols, and skills exercised in the preschools (e.g., "2", "samosa" to designate a triangle). At the last two time points, the symbolic math tests focused on children's mastery of the language, symbols and skills taught in their first year of primary school (e.g., "15", "triangle").

Results and policy lessons

Playing intuitive math games with preschool students in Delhi produced a long-term increase in children's intuitive numerical and spatial skills and a short-term increase in their mastery of the math symbols used in the preschools, but it did not improve their learning of the formal math skills taught in primary school.

Short-term gains: Immediately following the intervention, students in the math games group had higher intuitive and formal math scores, suggesting that the games enhanced math learning during preschool. For example, students in this group knew more number words and symbols and used informal language correctly to designate geometric forms. Students in the social games group also showed higher math scores than those in the no-treatment condition, but lower than those in the math games group.

Longer-term gains: By midway through the first year of primary school, all groups had similar formal math gains, suggesting that the games did not improve formal long-term learning outcomes. However, after one year of primary school, the students in the math games group continued to have higher intuitive numerical and spatial abilities. Indeed, the impact of the math games on these abilities, relative to the social games, was as large at the end of Grade 1 as it was a year earlier, at the end of the intervention.

Cost-effectiveness: For a six-student group to play the math games for four months, Pratham spent US$316. Since reusable materials for the games were 69 percent of the total cost, the cost-per-pupil would drop substantially for each additional

intervention cycle.

Overall, this research suggests that preschool interventions informed by basic research in cognitive development can be scaled to implementable interventions in the field. While only short-term school-relevant math gains were observed in this study, future game-based curricula might work better when they are integrated with age-appropriate exercises of mathematical language and symbols, and when they are introduced in primary schools. More research is needed to determine whether including formal math content or continuing to play games in primary school could make the games more effective as a foundation for school math learning.

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1. J-PAL Policy Bulletin. 2016. “Early Childhood Engagement for Lifelong Learning.” Cambridge, MA: Abdul Latif Jameel Poverty Action Lab.

2. The World Bank. "School enrollment, primary (% net).” Accessed September 5, 2019. https://data.worldbank.org/indicator/SE.PRM.NENR?locations=IN&most_recent_year_desc=false.

3. “Pratham Baldawi.” Accessed August 18, 2017. https://educationinnovations.org/program/pratham-balwadi.