Early Literacy Promotion Using Automated Hovering Among Young Minority Children

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ABSTRACT

OBJECTIVE: To determine feasibility, acceptability, and explore outcomes of behavioral economic (BE) strategies to increase parent-child shared reading within a Reach Out and Read program.

METHODS: We conducted rapid-cycle interviews with 10 parents to assess text messages followed by an 8-week randomized controlled trial of 3 BE strategies at 2 urban primary care practices: daily text messages (texting); daily text messages and regret messaging (regret); or daily text messages, regret messaging, and lottery participation (lottery). Parent-child dyads were eligible if children were < 24 months old, Medicaid-eligible, and had access to phones capable of receiving and sending text messages. Parents completed the Read Subscale of the StimQ and Parenting Stress Index-short form (PSI-SF) pre- and postintervention, MacArthur Communicative Development Inventory (CDI), Devereux Early Childhood Assessment (DECA), and a satisfaction measure postintervention. Differences between groups were assessed using intention-to-treat analysis.

RESULTS: Of 45 dyads randomized, 41 (91%) completed the study. Most participants were Black with incomes < $55,000. Parents reported reading on average 4 d/wk with no change in the reading frequency over time. StimQ scores increased over time, but there were no significant differences in StimQ, PSI-SF, CDI, and DECA scores between groups. Parents in all 3 groups reported satisfaction (3.8/5.0) with the intervention.

CONCLUSIONS: Implementation of BE strategies in 2 Reach Out and Read programs was feasible, near acceptable, and improved home reading environment scores. Future study should investigate BE strategies vis-à-vis usual care and be of sufficient duration and intensity to engage participants to assess its impact on patient and parent outcomes.

KEYWORDS: behavioral; child development; economics; literacy; Reach Out and Read

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WHAT'S NEW

Behavioral economic strategies have been employed to modify smoking, weight loss, and other behaviors but have not been tested with parent-child shared reading. We found these strategies were feasible, near acceptable, and improved the home reading environment among low-income parents.

Early childhood is a sensitive period in which young children develop foundational skills necessary for communication.[1] Unfortunately, language and socio-emotional delays are common among children under 3 years of age residing in impoverished communities.[2,3] These delays contribute to poor educational and functional outcomes later in childhood and represent an important cause of disparities in educational achievement.[4–6]

Parent-child shared reading represents an important source of language stimulation that can mitigate disparities in educational achievement.[7] Previous studies have found that parent-child shared reading is associated with improved language functioning, better school performance, less harsh parenting, and fewer disruptive behaviors, especially for children from low-income families.[8–11] Early literacy programs, such as Reach Out and Read (ROR) and Imagination Library, promote shared reading and distribute board books to low-income children to enhance literacy skills.[7,12] Despite the widespread adoption of these programs, parents of young

children from low-income communities do not consistently engage in reading activities with their children. Barriers including lack of time, lack of understanding of the importance of reading, difficulty developing daily reading habits, stress and fatigue, and competing priorities have been cited as factors limiting consistency in parent-child shared reading.[13]

Behavioral economics (BE) represents behavioral change strategies designed to incentivize behavioral change based on economic and psychology principles. These strategies, which include automated hovering, regret messaging, and financial incentives, have previously shown benefits at improving medication adherence, smoking cessation, immunization uptake, health care utilization, and weight management.[14–19] BE strategies have the potential to shape parent-child reading behaviors and improve language and socio-emotional development in young children. The aim of this pilot study was to test the feasibility, acceptability, and explore outcomes of 3 commonly employed BE strategies (automated hovering, regret messaging, and lottery incentives). This is important to determine the approach and sample sizes for future studies.

METHODS

PARTICIPANTS

We conducted a 2-phase study consisting of qualitative rapid-cycle interviews followed by a randomized controlled trial at 2 urban pediatric practices with active ROR programs. Parent-child dyads were eligible to participate if children were 6 to 24 ages months old, had Medicaid insurance, and had a phone capable of receiving and sending text messages. The study was approved by the Institutional Review Board at the Children's Hospital of Philadelphia and registered with Clinicaltrials.gov prior to enrollment of the first patient (NCT04576481) (Figure).

PROCEDURES

Parents participated in rapid-cycle interviews to assess text messages designed to increase parent-child shared reading. An example is "reading when your baby is young will help them develop a love of reading." Then, parent-child dyads were recruited at well-child visits and provided written informed consent. Dyads were stratified by site and randomized 1:1:1 using a random number generator to 1 of 3 arms of the intervention: 1) automated hovering (texting arm), 2) automated hovering and regret messaging (regret arm), or 3) automated hovering, regret messaging, and lottery incentives (lottery arm) for 8 weeks. In the texting arm, automated hovering consisted of daily text message reminders that provided education and coaching tips to address barriers to reading. In the regret arm, parents received automated hovering and were asked to respond whether or not they read with their child that day. Regret messaging consisted of a follow-up text message that informed participants if they were included as part of the proportion who read that day (affirmative response) or not (negative or no response). In the lottery arm, parents received automated hovering and regret messaging but were only enrolled into a daily lottery if they responded that they had read to their child that day. Each participant enrolled in the daily lottery received a 2-digit number to receive small ($5) or large cash prizes ($20). We utilized the University of Pennsylvania's Way-to-Health program, a text-messaging platform capable of 2-way communication and lottery incentives, to provide the BE strategies.

MEASURES

After enrollment, parents were emailed a link to their surveys in REDCap and were asked to complete study measures at baseline and following the intervention. At enrollment, parents completed a survey of demographic

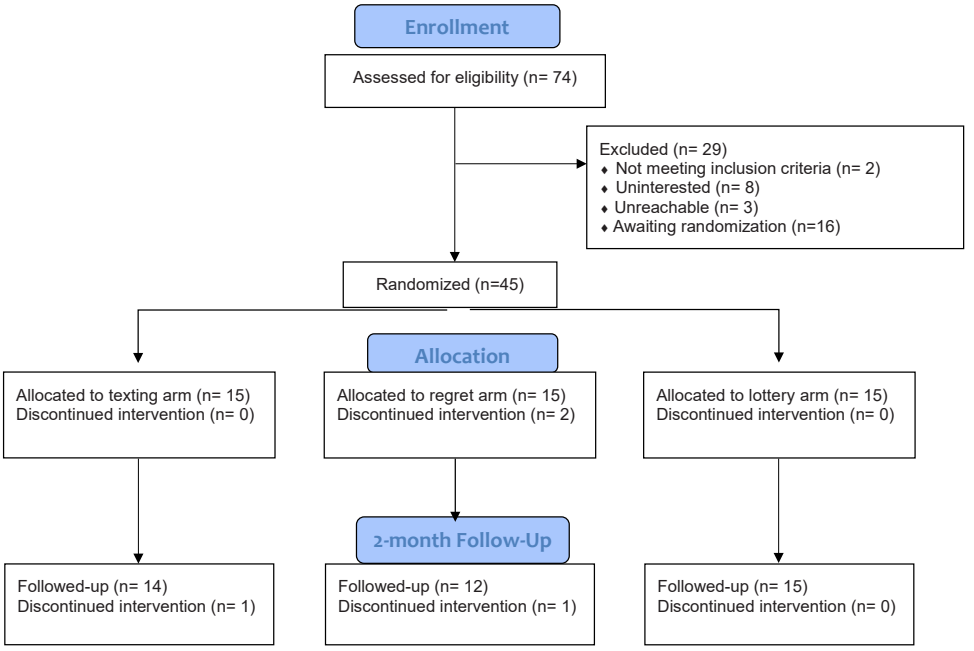

Figure. *Study flow diagram. *Total of 4 participants did not complete the 2-month follow-up.*

characteristics. Since this was a pilot trial, the primary outcomes consisted of the feasibility and acceptability of the study. Feasibility was measured as the proportion of participants who completed the study. Acceptability was measured at follow-up using a 5-point Likert-scaled question on overall satisfaction ("overall, I think the Read2Baby text reminder service helped me read more to my baby") and open-ended questions on what they liked or disliked concerning the BE strategies. Parents completed secondary outcome measures, including the Read subscale of the StimQ, the Parenting Stress Index-short form (PSI-SF), the MacArthur Communicative Development Inventory (CDI), and the Devereux Early Childhood Assessment (DECA). The Read subscale of the StimQ is a validated 10-item parent report measure of the home reading environment and was completed at baseline and follow-up.[20] A question on the StimQ asked parents the number of days they read to their child in the past week. The PSI-SF is a validated 36-item parent-report scale of parenting stress and was completed at baseline and follow-up.[21] The CDI is a validated parent-report scale of early language comprehension, while the DECA is a validated 33-item parent-report scale of socio-emotional problems, both of which were completed at follow-up.[22,23]

Analysis

To determine feasibility, we determined the proportion of participants who completed the study by intervention arm. To determine acceptability, we assessed mean satisfaction scores by intervention arm and examined responses to the open-ended questions. Differences between arms in the proportion who completed the study and satisfaction scores were assessed using standard inferential statistics. We regarded the study as feasible if 80% of participants completed the study and acceptable if average satisfaction was 4.0, similar to previous studies we conducted with this patient population. A *P*-value less than .05 was considered statistically significant. To explore outcomes, we examined differences between baseline and follow-up using intention-to-treat analysis in mean weekly reading frequency, mean StimQ Read Subscale scores, mean PSI-SF scores, and differences in mean CDI and DECA scores at follow-up between arms using 1-analysis of variance. Given the small number of participants in each arm, we elected to examine unadjusted differences.

Results

We conducted the 2-phase study at 2 primary care practices from November 17, 2020 to February 4, 2022. In phase 1, 10 eligible mothers participated in rapid-cycle interviews to review and finalize coaching tips for incorporation as text messages. In phase 2, 74 potentially eligible children were recruited (Figure). Twenty-nine were deemed ineligible due to the following: declined (n = 8), unreachable (n = 3), not meeting eligibility criteria (n = 2), and awaiting contact at enrollment completion (n = 16). Forty-five eligible parent-child dyads were enrolled and randomized, 15 to each study arm.

The majority of enrolled participants were male (54%), Black (81%), and had a mean age of 11.7 months (Table 1). Most parents were single (65%), with ≤high school education (56%), and a family income < $25,000 (51%).

Regarding feasibility, 2 participants in the regret arm withdrew after enrollment, citing an inability to meet protocol demands. An additional participant in the texting arm and the regret arm were lost to follow-up. Therefore, 41 (91%) completed the study.

Table 1. Child Demographic Characteristics by Group*

	All n = 45	Texting n = 15	Regret n = 15	Lottery n = 15
Gender (%)				
Female	20 (44.4)	8 (53.3)	8 (53.3)	4 (26.7)
Male	25 (55.6)	7 (46.7)	7 (46.7)	11 (73.3)
Mean age in months (SD)	11.8 (4.0)	11.6 (4.7)	11.9 (3.3)	12.1 (4.1)
Race (%)				
Black	35 (81.4)	14 (93.3)	8 (61.5)	13 (86.7)
White	3 (7.0)	1 (6.7)	0	2 (13.3)
> 1 race/other	5 (11.6)	0	5 (38.5)	0
Ethnicity-Hispanic (%)	2 (4.7)	1 (6.7)	0	1 (6.7)
Mean children at home (SD)	2.1 (1.4)	2.3 (1.8)	1.8 (1.2)	2.2 (1.1)
Parental marital status (%)				
Married/Living together	15 (34.9)	6 (40)	5 (38.5)	4 (26.7)
Single, never married	28 (65.1)	9 (60)	8 (61.5)	11 (73.5)
Parental education (%)				
< High school	3 (7.0)	0	2 (15.4)	1 (6.7)
High school	21 (48.8)	6 (40)	5 (38.5)	10 (66.7)
Some college/college graduate	17 (39.5)	9 (60)	5 (38.5)	3 (20)
Postcollege	2 (4.7)	0	1 (7.7)	1 (6.7)
Parental income (%)†				
< $25,000	19 (51.4)	4 (30.8)	7 (58.3)	8 (66.7)
$25,000–54,999	13 (35.1)	7 (53.8)	3 (25)	3 (25)
$55,000+	5 (13.5)	2 (15.4)	2 (16.7)	1 (8.3)

* Patients were randomized to text-messaging only, text-messaging plus regret, or text-messaging plus regret and lottery arms.

† Note: data missing for 5 parents on income.

Table 2. Average Days Reported Reading by Group*

Average Days Reading Per Week	Texting n = 14	Regret n = 12	Lottery n = 14	*P*-value
Baseline (SD)	4.1 (1.8)	4.0 (1.8)	4.8 (1.5)	.45
2 mo follow-up (SD)	3.9 (2.0)	4.2 (1.7)	4.9 (1.5)	.27
Change in days reading per week (SD)	−0.3 (2.2)	0.2 (2.6)	0.1 (1.7)	.19

* Patients were randomized to text-messaging only, text-messaging plus regret, or text-messaging plus regret and lottery groups.

The mean overall satisfaction score at follow-up was 3.8, indicating near adequate agreement for acceptability, but no differences across the 3 groups ($P = .32$). Responses to the open-ended questions suggested that participants liked the text messages. For example, 1 participant wrote, "I liked that the text alerts included other tips and ideas to help me with allowing my child to learn new concepts." However, some indicated that they disliked the frequency and timing of the texts. For example, 1 participant wrote, "The thing that I think should change should be more times or later times; some parents don't read to the kids that early so on days I don't read early, I just say no, but I do read later that day, but no later than 8." Some disliked the regret messaging regarding "the questions about the duration and title of the book. Just a reminder is enough." One parent remarked about the lottery arm: "Reading to your kid, educating your kid, giving them a little bit more knowledge, letting them, that is, something money can't buy. So, I don't even think it (lottery) should be offered." Overall, parents reported enjoying the reminders to read with their children. For example, 1 parent remarked, "when I'm reading, I'm making these noises and I'm making these sounds, trying to make these voices. She's just cracking up like it's just no tomorrow. So, that'll definitely keep me going."

Participants reported reading on average 4 d/wk at baseline with no difference between groups (Table 2). There were no statistically significant changes in the weekly reading frequency at follow-up in any group or between groups. Responses to text messages in the regret and lottery arms were only provided with affirmative responses and only 21% and 41% of the times, respectively.

StimQ read subscale scores increased across all groups (mean change 2.0, $P < .00$), but there were no between group differences (Table 3). PSI-SF scores did not significantly increase across all groups (mean change 5.6, $P = .16$) or between groups. There were no statistically significant differences between groups in CDI Comprehension percentile scales or mean DECA Initiative and Attachment Relationship scale scores at follow-up.

DISCUSSION

To our knowledge, this is the first study to evaluate the use of BE strategies on parent-child shared reading. We found the strategies to be feasible to implement and close to acceptable among a predominantly low-income urban African American population.

The results from this pilot trial suggest that BE strategies when implemented for 2 months did not increase the frequency of parent-child shared reading but did improve the home reading environment. These findings are consistent with prior research investigating the use of text-messaging alone on shared reading. Jimenez et al[24] conducted a hybrid effectiveness-implementation trial in which 137 participants received twice weekly text messages promoting shared reading for 6 months. The results showed a modest improvement in the home reading environment but no difference in reading frequency.

It is not clear why the BE strategies did not change the frequency of parent-child shared reading in this study. It may be that text messages, while viewed positively, are insufficient alone as a tool to help low-income parents overcome perceived barriers to more frequent reading, as suggested by Jimenez et al. It may also be that the frequency, duration, and parent engagement with the BE strategies in these 2 studies were insufficient to affect change in reading behaviors. We provided automated hovering with or without regret messaging and/or lottery incentives in all 3 arms daily for only 8 weeks. Meanwhile, Jimenez et al[24] provided text messaging for 6 months but only twice weekly. As a comparison in a study of glycemic control among adults with diabetes, Sen et al[25] found that daily reminders combined with lottery incentives for 3 months resulted in more frequent use of wireless glucometers and better glycemic control. In this latter study, the longer duration of daily messaging combined with financial incentives likely resulted in higher engagement among participants and better outcomes.

There are limitations to these findings. First, the study was conducted in a single geographic area and may not be

Table 3. Differences in Outcomes Between Groups*

Outcome	Texting n = 14	Regret n = 12	Lottery n = 14	*P*-value
Change in StimQ Read subscale (SD)	1.8 (2.8)	3.2 (4.0)	1.3 (2.7)	.32
Change in PSI-SF Scale (SD)	2.2 (18.2)	5.3 (16.4)	9.0 (34.4)	.78
CDI Comprehension Scale (SD)	84.6 (29.7)	78.5 (33.2)	63.1 (42.6)	.30
DECA Initiative Scale (SD)	77.6 (18.7)	64.3 (27.3)	72.1 (28.6)	.41
DECA Attachment Relationship Scale (SD)	79.4 (19.4)	66.6 (31.2)	75.6 (27.8)	.46

CDI indicates Communicative Development Inventory; DECA, Devereux Early Childhood Assessment; and PSI-SF, Parenting Stress Index-short form.

* Patients were randomized to text-messaging only, text-messaging plus regret, or text-messaging plus regret and lottery groups.

generalizable to other locations and populations. Second, we omitted a usual care control group. As a result, we were unable to isolate the individual effects of the 3 BE strategies compared to usual care. Third, the pilot trial was small and underpowered to find statistically significant differences in outcomes. Future studies should incorporate larger adequately powered sample sizes. Fourth, we were unable to determine if participants reliably read all daily text messages, as responses to text messages were limited. Fifth, we only measured the frequency of reading, not the duration or quality of daily reading.

We conclude that the use of BE strategies for parent-child shared reading involving text messaging, regret messaging, and lottery incentives was feasible, near acceptable, and associated with improved home reading environments among participants in 2 low-income pediatric practices with active ROR programs. Future research assessing the effects of BE strategies on parent-child shared reading should employ a usual care control group, have adequately powered sample sizes, and utilize BE strategies of sufficient duration and intensity to adequately engage parents in behavior change.

DECLARATION OF COMPETING INTEREST

None.

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