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Effects of a Virtually Delivered Reading and Embedded Mindset Intervention on Reading Performance for Fourth-Grader Struggling Readers

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The purpose of this study was to examine the effects of a virtual intensive reading intervention embedded with mindset training compared with typical reading instruction in a business-as-usual (BAU) condition delivered to fourth-grade students with or at risk for reading disabilities. After screening, the 59 participants were stratified and assigned randomly to condition. Highly trained interventionists delivered the intervention one-to-one with high fidelity and student engagement during the intensive intervention. Classroom teachers delivered the BAU. We examined the effects of the intervention on a variety of standardized timed and untimed measures of word reading and decoding, reading fluency, comprehension, and mindset. We addressed two research questions: What are the effects of intensive virtual reading intervention embedded with mindset training relative to a BAU comparison on the reading outcomes of fourth-grade students with or at risk for reading disabilities? Was initial mindset related to student response to intervention? Data analyses examined the main effect and moderation using linear mixed effects models. Significant differences in reading favored the virtual treatment condition for letter and word identification (g = 0.38). No other significant effects were observed. We note limitations in our study and offer directions for future research, including the need to explore additional moderators. **Key words:** *mindset*, *reading intervention*, *upper elementary*, *virtual instruction*

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DATA from the National Assessment of Educational Progress (NAEP) reveal that only about a third (33%) of students identified as having a specific learning disability can read at even a basic level (NAEP, 2019). Furthermore, NAEP data indicate an overall decline in the percentage of all fourth graders who read at or above proficiency from 37% to 35% from 2017 to 2019 (NAEP, 2017, 2019). Improving reading performance of students who struggle to learn to read during the elementary years has been an important public health challenge. The Every Student Succeeds Act (2015) required schools to implement multitiered systems of support to improve reading outcomes and to support students' social, emotional, and behavioral needs to accelerate their reading performance. However, the COVID-19 pandemic disrupted schooling in the United States and only exacerbated the need for intensive intervention, which motivated our study. For example, by fall of 2020, responses from a large household survey conducted by the U.S. Census Bureau indicated that a vast majority of students were learning at home using online resources or paper materials sent home by schools (The Household Pulse Survey; https://www.census.gov/data/experimental-data-products/household-pulse-survey.html). Respondents also indicated that students' classes were canceled or were negatively impacted in other ways during the school year. Only a minority of respondents (fewer than 10%) reported that the pandemic did not affect how their children received education.

Confirmation of the consequences of the pandemic was apparent in data from a special administration of the NAEP Long-term Trend Assessment (2022); disturbingly, the average scores of 9-year-old students declined five points from 2020 to 2022, marking the largest decline since 1990. Struggling readers, children performing at the 10th and 25th percentiles, declined even more (by 10 and eight points, respectively). Similarly, findings from a large-scale study conducted during the pandemic that used a robust longitudinal student reading achievement database including more than 4.9 million students in grades 3–8 revealed that "any observed gains in reading were modest" (Kuhfeld et al., 2022; p. 8). The researchers reported that students' reading gains during the pandemic, specifically, were about 0.06–0.11 standard deviations behind their own growth in prior years. More than 70% of the participating students reported one or more challenges to learning, including distractions at home, family responsibilities, and pandemic-related concerns about health. Similarly, teachers reported obstacles such as moving back and forth between in-person and online learning, coping with staffing shortages, and student safety and educational needs. Kuhfeld et al. also found that the pandemic disruptions exacerbated racial and socioeconomic inequities in reading achievement.

Understanding whether and how virtually delivered interventions may be a potential tool for improving reading performance among fourth graders who are at risk or who have reading disabilities motivated our present study. We have organized this article to begin with our theoretical framework and review of the literature that guided our study as well as our rationale for selecting a particular intervention and for embedding mindset within the intervention. Next, we describe our study methods, foreshadowing some challenges related to conducting a virtual intervention that was intended to support fourth graders' reading performance during the pandemic. Then, we describe our findings and discuss some implications, limitations, and directions for future research.

THEORETICAL FRAMEWORK: SIMPLE VIEW OF READING AND GROWTH MINDSET

Our theoretical framework for understanding interventions to improve reading performance includes the *Simple View of Reading* (Gough & Tunmer, 1986). This framework explains that the ability to read, and understand what one reads, is the product of

foundational decoding and linguistic comprehension skills. In typical reading instruction, the proportions of time divided among these skills may initially include more foundational decoding, listening comprehension, and vocabulary during early grades, with relatively more focus on fluency and reading for comprehension and generalizing to reading in content areas in upper elementary grades. Nevertheless, students who struggle to learn to read require more focus on word-level skills. In addition, the Component Model of Reading (Aaron et al., 2008) and the Direct and Indirect Effects Model of Reading (Kim, 2020) extend the *Simple View* to include additional nonreading component skills in the cognitive, psychological, social, and emotional domains.

These nonreading skills are important because converging evidence suggests that students with persistent reading difficulties develop negative beliefs about themselves as readers, less motivation to read, and maladaptive attributions about their effort (e.g., Chapman & Tunmer, 1997; Toste et al., 2020; Tsujimoto et al., 2019). By fourth grade, students with reading difficulties also demonstrate lower self-efficacy than peers who are typical readers (Cho et al., 2015). Moreover, students' attitudes toward reading are related to their reading performance (Petscher, 2010). In addition, reading difficulties lead to increased anxiety, and increased anxiety may be related to weaker response to reading interventions (Grills et al., 2014).

Hence, another framework that guided our intervention was Mindset theory (e.g., Dweck, 2006), which emphasizes the importance of developing a growth mindset with the belief that skills can grow over time with effort. By contrast, students with a fixed mindset believe that skills and intelligence are static and out of their locus of control; hence, they do not attribute their growth to effort but rather to external factors such as task ease or luck. Sisk et al. (2018) conducted a large meta-analysis that reported small but significant positive relations between mindset and academic achievement ($d = 0.08$), with relatively larger effects (with borderline significance) for students at risk academically ($d = 0.19$) and significantly larger effects for students from lower socioeconomic backgrounds ($d = 0.34$). Other reviews have also described the effects of broader social and emotional competence on a range of academic performance outcomes (e.g., Domitrovich et al., 2017; Durlak et al., 2011).

READING INTERVENTION COMPONENTS FOR UPPER ELEMENTARY STRUGGLING READERS

Research has shown that remediating reading difficulties for students in the upper grades becomes more difficult, and research syntheses have reported that the effects of interventions are generally smaller than when conducted with younger students in the primary grades (Al Otaiba et al., 2022a). To better understand the effects of reading interventions for upper elementary students with reading difficulties (grades 4 and 5), Donegan and Wanzek (2021) conducted a synthesis of the literature that included 33 studies. Most studies were conducted in small groups (one to seven students), and many of these interventions were relatively brief, providing less than 30 sessions of treatment. They reported the mean effect sizes of these interventions on standardized foundational code-focused reading outcomes and comprehension measures were small ($g = 0.09$ and 0.13, respectively). The magnitude of effects reported in this synthesis was slightly smaller but generally consistent with two prior meta-analyses on interventions for students with reading difficulties in grades 4–12 conducted by Scammacca et al. (2015) and Wanzek et al. (2013).

Donegan and Wanzek (2021) reported that most studies offered a relatively narrow focus for instruction, but those characterized as multicomponent had stronger impacts. The group size for intervention delivery moderated treatment outcomes in that there was a difference for foundational skills versus comprehension, with groups of four to seven

students having greater effects than either larger groups or smaller groups (one to two students) for foundational reading skills and a reversed pattern for comprehension, whereby the effects were stronger for smaller groups (one to two students).

MINDSET INTERVENTION COMPONENTS FOR UPPER ELEMENTARY STRUGGLING READERS

A small but growing body of research has used standardized reading measures when examining correlations between reading and mindset performance among students with or at risk for reading disabilities (e.g., Al Otaiba et al., 2022b). For example, Petscher et al. (2017, 2021) examined the mindset of fourth-grade students and reported a moderate, standardized relation between their growth mindset and reading comprehension ($\gamma = 0.43$), after controlling for students' word reading skills. There is also some evidence that students' growth mindset may predict growth over time and response to instruction in the upper grades (e.g., Cho et al., 2018; Tock et al., 2021).

In addition, a few studies have examined the efficacy of interventions that include reading and mindset intervention components. Positive effects were reported by Lovett et al. (2021), who tested the effects of intensive interventions that combined reading and mindset/motivation components compared with a business as usual (BAU) condition provided by schools. Researchers provided middle school struggling readers with small-group reading interventions three to five times per week (ranging from 40–60 min, for a total of between 100 and 125 hr). Their multicomponent intervention included code- and meaning-focused elements and incorporated a strand of positive attribution and motivational strategy training. Students in the treatment condition significantly outperformed students in a BAU control condition on standardized measures of letter–word identification ($g = 0.56$) and word attack/decoding ($g = 0.78$). In addition, students in the treatment condition reported an improved sense of competence in reading relative to controls ($g = 0.61$). There were no significant differences between conditions on reading comprehension.

Nevertheless, other researchers have reported mixed findings about the value added of mindset-like training combined with reading interventions when compared with reading-only interventions. For example, Toste et al. (2017, 2019) conducted a pair of studies that used a similar explicit reading intervention focused on blending, segmenting, reading, and spelling multisyllabic words. They compared two treatment conditions (reading-only or reading plus motivation components such as improving effort and positive attributions) with a BAU condition. In the first study, the researchers provided the small-group intervention three times per week for 40 min across 8 weeks. Students in both treatment conditions significantly outperformed the BAU on timed sight word reading and on a measure of reading attributions. Students in the combined condition had higher sentence comprehension than those in the reading-only group. Similarly, in the second study by Toste et al., students in both treatment conditions outperformed the BAU students on most standardized measures of word reading (effect sizes ranged from 0.17 to 0.43) and on comprehension (effect size = 0.26). However, in this second study, Toste et al. shifted to a measure of reading self-concept for motivation and they found that the BAU students improved more in their self-concept.

Another recent study (Wanzek et al., 2020) compared the effects of two treatments, a reading-only and a reading plus mindset intervention, with a BAU condition. The researchers selected a structured reading intervention, the Lindamood Phoneme Sequencing Program (LiPS; Lindamood & Lindamood, 2011). The LiPS was selected on the basis of the evidence of efficacy for commercially available intensive interventions for students with severe word reading difficulties (e.g., Torgesen et al., 1999). For mindset, they selected a commercially available stand-alone

mindset intervention that was widely used (Brainology Mindset Works, 2016). The study sample included fourth-grade struggling readers (students who scored below the 30th percentile on word reading). Researchers provided reading intervention to small groups (three to five students) for 45 min per day for an average of 73.5 sessions. Researchers also provided Brainology training to small groups of students assigned to the combined condition. Both treatment conditions outperformed the BAU on standardized measures of nonword reading ($d = 0.29$ and 0.35, respectively). Students in the reading-only intervention significantly outperformed the BAU on phonological processing ($d = 0.28$). Students in the reading plus Brainology condition also showed a positive trend ($d = 0.23$) on phonological processing. However, there were no significant differences favoring either treatment condition relative to the BAU condition on reading comprehension or on mindset measures. The sample was large enough to conduct exploratory moderation analyses, which revealed no differences in outcomes related to initial overall reading achievement or problem behaviors. Students with a higher initial growth mindset and higher initial phonological processing scores had greater phonological processing outcomes.

Study purpose

Our study was designed to add to the research on intensive reading interventions that incorporate social and emotional supports for upper elementary students with significant word-reading difficulties. More specifically, we intended to extend the study of Wanzek et al. (2020) by *embedding* a mindset intervention into a reading intervention (rather than implementing a stand-alone mindset intervention combined with a stand-alone reading intervention) for students with or at risk for reading disabilities, thus addressing student mindset in a specific area of difficulty for these students. Our study was a preregistered clinical trial that was initially intended to include two cohorts of students and to be conducted live and in schools, but the first year of the study (2019–2020) was interrupted by the COVID-19 pandemic when university personnel were not allowed in schools. We conducted the current study during the 2020–2021 school year; as the COVID-19 pandemic continued, schooling was largely virtual, and tutors were not allowed to provide in-person instruction. Therefore, we delivered the intervention virtually to students, whether they were learning at home or in their school classrooms.

The purpose of the study was to examine how this year-long virtual intensive word-level reading intervention embedded with mindset training compared with typical reading instruction in a BAU condition delivered by classroom teachers to fourth-grade students with or at risk for reading disabilities. Highly trained interventionists delivered the intervention one-to-one. We monitored the fidelity of implementation and the level of student engagement during the intensive intervention. We examined the effects of the intervention on a variety of standardized timed and untimed measures of word reading and decoding, reading fluency, comprehension, and mindset. We addressed two research questions: First, what are the effects of intensive virtual reading intervention embedded with mindset training relative to a BAU comparison on the reading outcomes of fourth-grade students with or at risk for reading disabilities? Second, was initial mindset related to student response to intervention? We hypothesized that students in the intervention condition would improve their word-reading outcomes more than students in the BAU condition. Based on prior studies and reviews of the literature, we did not hypothesize that there would be significant differences in reading comprehension or growth mindset development favoring the intervention students, though we did hypothesize that students with relatively lower mindset scores might benefit more from the intervention than from the BAU. However, given our relatively small sample, we were unsure we had adequate power to detect differences.

METHOD

Participants and research design

For this randomized controlled design study, we recruited fourth-grade students from two schools in two school districts across two urban areas of the United States. One school was in a midsized city in the southeastern part of the United States, and the other school was in a large city in another state in the south. Classroom teachers were asked to identify students with reading disabilities or those reading below grade level for potential participation in the study. Students identified with vision, hearing, or intellectual disabilities were excluded from the study to align the intervention with student needs. Nominated students with signed parental consent were screened to determine eligibility for study participation.

A total of 59 fourth-grade students with or at risk for reading disabilities qualified for the study and were assigned to treatment ($n = 31$) or comparison ($n = 28$) conditions using stratified random assignment based on screening performance (described in more detail in the study procedures). Both schools provided demographic information on study participants. Of the total sample, 53% ($n = 31$) were female. The racial composition of the study sample was 73% ($n = 43$) White, 20% ($n = 12$) Black, and 2% ($n = 1$) Asian American. In terms of ethnicity, 75% ($n = 44$) were identified as Hispanic (5% provided only ethnicity but no race information). Fifty-one percent of the sample were reported to be English language learners, and all study participants received instruction in English. Most participants in the study qualified to receive free or reduced-price lunch ($n = 46$; 78%). Schools reported that 8.5% of participants had an identified disability ($n = 5$); three were identified as having a specific learning disability, one had a speech impairment ($n = 1$), and one was on the autism spectrum.

Throughout the study, overall and differential attrition was low (What Works Clearinghouse, 2020). After completing the pretest assessment battery, two students from the BAU comparison condition (3.3% of the total sample; 6.7% of the BAU comparison) either moved and therefore withdrew from the study or were absent for all possible assessment days. The relation between overall (i.e., 3.3%) and differential attrition (i.e., 6.7%) indicates low expected bias using liberal attrition standards (Institute of Education Sciences, 2020).

Study procedures

Students completed a battery of pretest measures in late September and early October before being assigned to study condition. The participants were stratified on the total word reading efficiency score using the Test of Word Reading Efficiency—Second Edition (Torgesen et al., 2012), which is described later in our description of the study measures. We rank-ordered students' scores within each school, created similar student pairs, and randomly assigned students within pairs to either treatment or a school-provided BAU comparison condition. The stratified random assignment occurred blindly, using only student ID numbers for assignment. Students participated from October to the end of April/beginning of May. The same test battery was administered at the beginning of May within 2 weeks of intervention completion for posttest assessment.

Because of the ongoing pandemic, as previously noted, research staff were not allowed to enter the schools. Teachers provided Tier 1 instruction during their language arts block in person or virtually and our team was not able to observe this instruction. A total of 30 students' families (16 in the BAU and 14 in the treatment condition) initially elected for their children to receive instruction in person, with the remainder learning from home. When students learned from home, schools provided them with a computer that was webcam enabled and a mobile hot spot if needed. Any BAU supplemental reading intervention was provided by classroom teachers or the school staff; later, we describe the limited amount of formal intervention that

was provided beyond Tier 1. The embedded mindset reading intervention was provided one-on-one via the school's online video platform (i.e., Zoom or Microsoft Teams) with a university-hired and trained interventionist. Intervention sessions were scheduled for 30–60 min each day, 4–5 days a week. Differences in intervention session length varied by teacher and student based on student availability. Student availability varied on the basis of school closures or individual quarantines due to COVID-19 as well as a large winter snowstorm that impacted both research sites and had lingering effects on the availability of electricity and, hence, the internet. The majority of participants in the treatment condition ($n = 27$) received intervention 4 days a week for 45 min each day. Individual students received 1–78 sessions of intervention ($M = 41.06$, $SD = 22.97$) depending on school and attendance.

Description of embedded mindset and reading intervention (EMLIPS)

The reading component of the EMLIPS intervention was the Lindamood Phoneme Sequencing Program (LiPS; Lindamood & Lindamood, 2011), with additional mindset-related supports embedded throughout the intervention. The LiPS is a reading intervention program to support students with or at risk for reading disabilities using explicit and systematic instruction and each lesson has five components (review, new instruction, tracking, reading/spelling, and reading connected text for fluency and comprehension); the amount of time for each component varies slightly depending on the progression through the program's scope and sequence. The LiPS provides instruction to help students learn letter–sound relations through feeling the oral motor movements required to produce each sound in words. Instruction also includes opportunities for students to apply their letter–sound knowledge as they track changes (additions, substitutions, deletions) in the phonemes and eventually syllables in the words they hear, to read targeted and decodable word lists, to spell decodable words, and to read connected texts. The scope and sequence of LiPS begin with providing instruction on single-syllable words and gradually increase in complexity to provide instruction on multisyllabic words. Within the fluency and comprehension components of this intervention, students practice word reading and applying their letter–sound knowledge and decoding skills to automatically and fluently read connected text. Interventionists supported their students' fluent reading by providing feedback and error correction when necessary. Interventionists also supported students' comprehension through a preview of the text and text-specific comprehension questions during and after text reading. They also provided explicit instruction in identifying the main idea of a portion of text and then synthesizing the main idea into a 10-word gist statement. A typical face-to-face intervention session lasts 45 min; to accommodate virtual learning, we adjusted intervention sessions to range from 30 to 60 min.

We embedded elements of growth mindset training into the LiPS reading intervention; these activities introduced habits related to a growth mindset (e.g., persistence, practice through repetition, taking on challenges), the differences between growth and fixed mindsets, and strategies for applying a growth mindset when faced with academic challenges. Interventionists used a Mindset Master Pathway that we developed as a visual road map of the habits and concepts (e.g., growing a strong reading brain, using repetition and practice, learning from the past, and choosing a growth mindset). Figure 1 provides a visual summary of this Mindset Master Pathway; note that it represents a partially completed pathway, with the first seven achievements mastered and the relevant game badges students earned on the left-hand side. It was designed as a gameboard-like visual support, and participants chose a character to represent their journey to becoming a "mindset master," collecting "achievements" along the way. Each achievement was associated with a habit or

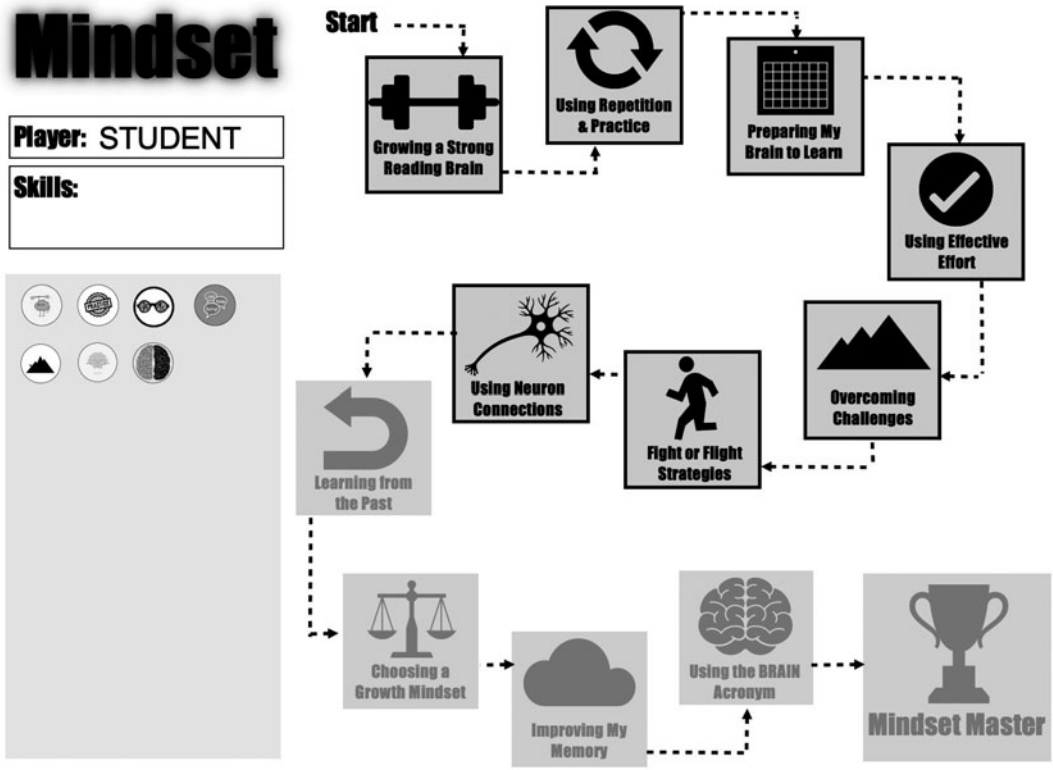

Figure 1. Mindset Master Pathway. This figure displays the Mindset Master Pathway that was used as a visual representation of all the skills and concepts introduced throughout the intervention related to growth mindset. This is a partially completed Mindset Master Pathway with the first seven "achievements" mastered.

concept taught through the embedded portions of the reading intervention. The embedded components included (1) using mindset language (e.g., "This has been a tough concept that you've been working on for a while. Your strategies are really working for you, and your hard work is paying off!"), (2) providing student mindset conferences to encourage students to self-reflect on their current mindset (fixed, mixed, or growth), (3) supporting goal setting toward a growth mindset, and (4) incorporating reading mindset-related texts during component five of LiPS. Hence, we named our intervention EMLIPS to represent embedded mindset with the LiPS program. Figure 2 provides a sample lesson plan indicating how LiPS and growth mindset were meshed in each lesson (including the theme of the story students were reading) and Figure 3 is an example of one of the rubrics we created to help students self-reflect specifically about their persistence.

Interventionists and training

Ten reading interventionists on our research team implemented EMLIPS; all were female and White. One interventionist reported her ethnicity as Hispanic. All interventionists had a bachelor's degree, six also held a master's degree, and three were currently pursuing their master's degree. All interventionists had degrees in education-related careers (certified teachers, counseling/psychology, speech–language pathology, social work). Interventionists received four full days of training (7 hr/day) for EMLIPS before beginning intervention sessions with participants. The training focused on intervention procedures

Slide	Sample Lesson Plan/Script
Review of consonants, vowels, and expectancies.	
Slide shown assists in the consonant assembly within *LiPS* with grapheme tiles present	Targeted review of all borrowers. "Borrowers" is a term that is used in *LiPS* to refer to the sounds that borrow the sounds of other letter(s). These include "c", "x", "qu", and "y". Questions to ask: 1. Thumbs up/down if I'm circling the borrower that borrows vowel sounds? 2. Thumbs up/down if I'm circling the borrower that makes the /ks/ sound? 3. What sounds does "qu" borrow from? 4. What group does "c" belong in? Show BLANK SLIDE 1. Tell me any of our four borrowers. 2. What sound does it make? *Language Frame: "Borrowers are something that we have been working on for a bit, and I know they are tough, but I see that our practice has paid off! Keep it up!"*
Slide shown assists in the vowel assembly within *LiPS* grapheme tiles present	Targeted review of all the smile sounds in order. "Smile" sounds is a term used in *LiPS* to refer some of the tense vowel sounds on a continuum of vowel sounds. These include the sounds for long "e" and "a", and short vowel sounds for "i", "e", "a", and "u". Questions to ask: 1. Thumbs up/down if I'm circling the sound /i/? 2. Thumbs up/down if I'm circling a smile sound (circle 'ee')? 1. What sound does "ow" make? 2. What sound does "aw" make? Show BLANK SLIDE 1. Tell me a smile sound. 2. What letter(s) come to mind?
Slide shown assists in reviewing the two previously known expectancies as described.	Review of Signal E and Two Vowels Together expectancies. An "expectancy" within *LiPS* is presented as a likely way vowels sound. For example, when either paired with an "e" at the end of a CVC word (CVCe), or when vowels are paired together (i.e., "ai", "ea", and "oa"), but students are also encouraged and learn to be flexible decoders. Questions to ask: 1. If there is an 'e' at the end of a word, what expectancy is that? 2. What does this visual (visual support for Two Vowels Together) remind us of?
New expectancy to introduce	
Visual support for describing/demonstrating that the letter "c" borrows sounds such as /s/ and /k/	" C " . Borrowers are used to explain another expectancy for how the letter "c" in the word cycle can have two different sounds; both the /s/ and /k/ sound. "*Yesterday we learned about the borrower 'c' and how it sometimes borrows the /k/ sound and sometimes borrows the /s/ sound. You don't have to guess which of those sounds the 'c' will make in a word. There's an expectancy for the 'c'. Do you remember better if someone just explains something to you or if you get to see a picture too?* (pause for student response). *I agree, so we have this picture here…* Continue on with visual support to describe when students can expect "c" to borrow the /s/ sound and when to borrow the /k/ sound in words. Have student determine what sound the 'c' will make in ca, ci, ic, and ice. (/k/, /s/, /k/, /s/)

Figure 2. Modified sample lesson plan with objectives. This figure provides elements of an EMPLIS lesson with its modified LiPS lesson plan (review of letter sounds, phonemic awareness, phonics, fluency, and comprehension through text reading) and with embedded mindset-related components throughout. The language frames and text in italics reflect our embedded growth mindset (e.g., practice and persistence effective efforts). The lesson also includes a student–interventionist mindset conference. The rubric mentioned is in Figure 3. Note that the brief text about George Washington Carver also supports the theme of persistence. LiPS indicates Lindamood Phoneme Sequencing Program.

Tracking (PA)	
Virtual tracking mat with virtual bingo chip manipulatives to represent phonemes within spoken words	This activity is a PA activity during which students hear changes in sounds of spoken words (both real and pseudowords) and move a virtual manipulative to represent changes in sounds. Only one change (addition, substitution, or deletion) occurs at a time. kab → sab → seb → sib → sub → kub → kueb → kuebz → kuez → suez → uez
Reading and Spelling	
Interventionist uses a whiteboard and student uses notebook paper	**Hold up the visual for "c" expectancy as needed** Reading: code, scale, crimp, clown, cute, fact, cent, lace, slice, ounce, ceach, cinch Spelling: kid, cut, crit, kite, crash, keep, clump, king, cry, skip, scam, culp *Language Frame: "I am so proud of the effort you put forth during spelling today! You didn't give up even when we had some tough words to spell."*
Mindset Conference	
Persistence rubric shown in Figure 3, with space to write the student's current mindset and their goal	*We saw this rubric a few days ago, this rubric is about persistence and trying things again and again even if they are difficult. In our last mindset conference, we talked about practice. For today's conference I want you to specifically think about persistence. This rubric is laid out in the same way our practice rubric was with fixed on the left and growth on the right. Let's read these ratings together for persistence starting with fixed* (pause for student to read rubric or read it together, continue on with mixed and growth). *Great, I want you to think about our reading group today. Where do you think you fall on our scale of growth mindset today thinking about persistence?* (pause for student response) *I'm going to write that your current mindset is _____. Why did you rate yourself as _____?* (engage in a brief discussion of their rating, listening to their reasoning and then adding your own observations as well. If they have mixed or fixed mindset, reassure them that it is totally okay to have a fixed mindset and thank them for sharing just as we did during training/checkouts). *Let's make a goal for ourselves regarding persistence?* (pause for student response, you will type their goal on the screen, if the student is struggling to come up with an appropriate goal themselves you may need to guide them to a goal). *That's a great goal, we will keep that in mind over the next few days, I may even remind you of our goal so we can work on it together.* **write down goal in notebook to refer to later** *Remember the steps are review rubric, student rates, brief discussion, goal setting/writing*
Sight Words	
Flash cards on slide.	This is an opportunity for students to work on their word reading fluency. not, said, an, like, than, thing
Reading in Context – Mindset Text	
	Today we are going to finish our book on George Washington Carver. Let's preview the book a bit and activate our mindset knowledge for reading!

Figure 2. Continued

Reading in Context – Mindset Text Cont.	
Digital copy of book about George Washington Carver shown	Focusing on practice and persistence. General focus of text reading is reading accurately, fluently, and for comprehension. Provide error correction as necessary. *Yesterday we read the chapter Making a Difference. Can you remind me how George Washington Carver showed a growth mindset and persistence when he was helping the farmers?* *How does being persistent help, us have a growth mindset?* *Today we are going to finish our book and read these last few chapters – Ideas are Free and A Lasting Message. Do you think George Washington Carver will continue to show us persistence as he gets older?* Questions to ask during reading: 1. Who did George go to speak to? 2. Why didn't some of them want to hear him speak? 3. Who did Congress' new law help? 4. How did George demonstrate persistence when he was speaking to Congress? 5. How could we describe George Washington Carver's character? 6. Describe two times that George had to be persistent in his mindset to accomplish what he was able to do. Question to ask after reading: Do you think George Washington Carver's mindset and persistence contributed to his success in life? Why or why not?

Figure 2. (Continued)

and instruction on phonemic awareness activities, letter–sound relationships, reading and spelling single-syllable words, comprehension procedures, and mindset components to be embedded within the reading intervention. All lessons were delivered virtually, so interventionists also learned to provide this type of instruction and to work with schools' virtual delivery platforms. Interventionists received follow-up training in late November focusing on multisyllabic word reading, spelling procedures, and the synthesizing main idea comprehension strategy. Interventionists received feedback on implementation and coaching every 1–2 weeks. Interventionists also attended virtual monthly group meetings to discuss implementation; these meetings also provided opportunities to practice mindset-related components.

Embedded mindset reading intervention fidelity

We observed the interventionists once a month (M = 8.7; range of seven to nine fidelity visits/interventionist) to monitor interventionists' adherence to the intervention

	FIXED 1	MIXED 3	GROWTH 5
PERSISTENCE	I gave up as soon as intervention got hard. 	Work was hard today so I asked for help right away instead of trying to attack sounds and words. 	I "stuck to it" today and kept working hard. When words got hard, I worked even harder. 

Figure 3. Effective effort rubric for persistence. This figure is one of the effective effort rubrics used during student–interventionist mindset conferences. During student–interventionist mindset conferences, students self-identify and reflect on their current mindset (fixed, mixed, or growth). Student and interventionist set a goal together working toward a growth mindset. This rubric is referred to in Figure 2.

components. Each observer was trained to use a low-inference fidelity form through descriptive training and live observations. To establish interrater reliability, each observer met 90% or greater coding accuracy with the gold standard coder. Each component in the EMLIPS intervention was rated on a 4-point scale (3 = excellent implementation [all checklist items implemented accurately]; 2 = adequate implementation; 1 = weak implementation; and 0 = not completed [interventionist planned to complete component but did not]). We averaged the scores across intervention components to create an overall intervention implementation score. We also included three global ratings: instructional quality, student engagement, and overall mindset. These global ratings used a 3-point scale (3 = excellent [demonstrated six quality checklist items; all or nearly all the students actively engaged; and demonstrated all three mindset checklist items]; 2 = adequate; 1= weak [demonstrated fewer than four quality checklist items; most students not actively engaged; and demonstrated less than two mindset checklist items]). Quality checklist items included individualization, guided practice, pacing/wait time, monitoring, explicit and specific feedback, time management, and behavior management. Overall mindset checklist items included overall mindset language (i.e., incorporated mindset-related language, made connections to mindset concepts, and/or started intervention components with a mindset-focused objective), feedback/error correction that incorporates mindset, and responsiveness (i.e., avoided scripted responses and demonstrated responsiveness to student mindset needs).

The mean overall implementation fidelity ratings were high (2.78 out of 3 points), with individual interventionists' means ranging from 2.57 to 3.00. In addition, mean global instructional quality ratings were high (2.65), with individual interventionists' means ranging from 1.89 to 3.00. Mean student engagement ratings were also high (2.79), with individual interventionists' means ranging from 2.33 to 3.00. Mean overall mindset ratings were adequate (2.27), with individual interventionists' means ranging from 1.67 to 2.86.

We also observed the EMLIPS intervention with the Instructional Content Emphasis Instrument-Revised (ICE-R; Edmonds & Briggs, 2003) to record the amount of time an interventionist spent in each reading instruction component (e.g., phonological awareness, phonics/word recognition, comprehension). In addition, observers rated the overall instructional quality on a 4-point scale based on instructional delivery (specific feedback, modeling, pacing, scaffolding, etc.) and overall student engagement on a 3-point scale (3 = high engagement, 2 = medium engagement, and 1 = low engagement). Observers met reliability on the ICE-R by obtaining at least 90% reliability with the lead coder using a gold standard on practice videos prior to live observations. Observations indicated that EMLIPS sessions occurred for an average of 44 min (SD = 5 min) per observation.

During our observations across the year, we found that many of the students were receiving our instruction from their homes (73.68%), and the remainder (26.32%) were receiving our instruction from a classroom or another room in the school (e.g., cafeteria). This was somewhat surprising because, as we noted earlier, schools reported to us that roughly half of the families of students in the treatment condition had elected for them to learn in person. Phonics and word-reading instruction comprised the most amount of time in EMLIPS (M = 22.05 min [50%] of time; SD = 4.5 min). On average, EMLIPS also included comprehension instruction (M = 8.74 min [20%] of time; SD = 5.1 min), phonological awareness instruction (M = 6.68 min [15%] of time; SD = 3.5 min), other academic instruction (e.g., mindset-related discussion; M = 4.32 min [10%] of time; SD = 2.5 min), nonacademic instruction (e.g., transition time between activities; M = 1.68 min [4%] of time; SD = 1.6 min), and text reading with no other instruction occurring (M = 0.68 min [1%] of time; SD = 1.1 min). The other reading components (i.e., vocabulary, fluency, spelling) accounted for less than 1%

of instructional time. The average global instructional quality rating was 3.89, indicating high-average to excellent quality. The average global student engagement quality rating was 2.5, indicating a medium to high level of student engagement.

Supplemental reading instruction observations and instruction

We also gathered information on any supplemental reading instruction that was provided by the schools, with the intent to observe both school-provided BAU interventions and our EMLIPS treatment sessions to identify potential similarities and differences between conditions. The research team conducted brief interviews with classroom teachers in the fall and winter to identify any students (in both study conditions) who were receiving supplemental reading intervention beyond their core reading instruction. Teacher interviews indicated that only four students were receiving supplemental reading instruction.

We were able to observe supplemental instruction for two of those four participants during two observations in the spring. Teacher and school schedules and online learning platform access presented challenges in observing the other two students' supplemental instruction. We also collected anecdotal information about how the instruction was presented, given the context of the study during a pandemic (i.e., teacher-delivered instruction face-to-face or via an online video platform, students were learning remotely or in-person). Following the same ICE-R training and observation protocol as we had used to observe EMLIPS, observers recorded the amount of time a student received each reading instruction component and rated the overall instructional quality and student engagement. During the two observations, sessions occurred on average for 55 min ($SD = 7$ min) per observation. Both observations were of instruction delivered via an online video platform (i.e., the teacher was at home). In addition, during both observations there was a mixture of students who were in their school classroom logged in for instruction on individual devices and students who were at home learning remotely (including students who did not have their camera on, which made it challenging to determine whether they were at home or in a classroom at school). Other academic instruction (e.g., grammar instruction) comprised the most amount of time during observed reading instruction ($M = 28.5$ min [52%] of time; $SD = 6.4$ min) and nonacademic instruction (e.g., transitions, logging on to computers or specific computer programs, free time on the computer) also occurred ($M = 26.5$ min [48%] of time; $SD = 0.7$ min). The other reading components (i.e., phonological awareness, phonics and word reading, fluency, vocabulary, comprehension, spelling, and text reading) accounted for less than 1% of instructional time.

We also interviewed two teachers and asked them to describe challenges experienced during the 2020–2021 school year. Teachers reported that students and teachers found it difficult to pivot to online technology and that online learning content was not consistently available for all their students due to issues related to internet availability and stability. Whether students learned in school once attendance was an option, or learned at home, teachers expressed concern about students' motivation, attention, and a regression in social/emotional and academic learning related to the pandemic.

Measures

Given that the research staff could not enter schools due to the pandemic, all assessors were trained on the online administration of the assessment battery and scoring procedures. All assessments were adapted to be delivered in a PowerPoint format and presented via the online video platform for administration. Each slide within the presentation matched the printed copy of the student forms for each assessment. The assessments were given in presentation view, allowing only the test administrator to see the written instructions for administration,

including the scripts and prompts and information about basals and ceilings for each assessment. Prior to administration, assessors presented two slides (one with a picture of an apple and one with a sound clip of a dog barking) to ensure that the student could see the slides presented ("Look at this page. What do you see?") and hear the assessor sufficiently well via the online video platform ("Listen. What do you hear?"). This procedure ensured a proper testing environment before proceeding with the rest of the assessments. If there was an issue with either the visuals or the audio prior to administration, the assessor would contact a research team member for assistance or reschedule the assessment. Assessors scored the assessments on paper protocols collected by the research staff. Assessors were required to demonstrate 100% reliability with both administration and scoring prior to each administration time point. All assessors were blind to the participants' study assignment. Students were assessed at pretest and posttest on measures of reading achievement and mindset, described next.

Real and nonword reading

The Test of Word Reading Efficiency—Second Edition (TOWRE-2; Torgesen et al., 2012) is an assessment of word-reading fluency that includes two subtests (i.e., Sight Word Efficiency, or SWE, and Phonemic Decoding Efficiency, or PDE). As mentioned, we used this test to screen students for eligibility for the study and used their data to stratify and assign them to condition. The TOWRE-2 is an individually administered test. In the 45-s SWE subtest, students read a list of real words that increase in difficulty. In the 45-s PDE subtest, students read a list of decodable pseudowords (i.e., nonwords). The subtests are scored by the number of words read correctly within the time limit. The two subtest scores can be combined for a total word reading efficiency score. The average test–retest reliability for the TOWRE-2 is estimated at 0.90 for children aged 8–12 years. For children aged 9–10 years (i.e., fourth graders), both the SWE and PDE subtests have concurrent validity with the Word Identification subtest of the Woodcock Reading Mastery Test-Revised/Normative Update (Woodcock, 1998) estimated at 0.89 and 0.86, respectively.

We also administered the Letter–Word Identification (LWID) and Word Attack (WA) subtests of the Woodcock–Johnson Tests of Achievement—4th Edition (WJ-IV; Schrank et al., 2014) to assess participants' word-reading ability. Both subtests are individually administered and untimed and items increase in difficulty. The LWID subtest assesses students' real word reading ability, whereas items on the WA subtest include decodable pseudowords. Internal consistency reliability estimates range from 0.90 to 0.99.

Fluency

We assessed students' oral reading fluency (ORF) using the ORF subtest of the Dynamic Indicators of Basic Early Literacy Skills—6th Edition (DIBELS; Good & Kaminski, 2002). An assessor individually presented three grade-level passages to students. Students read the passage aloud for 1 min each. Scores are reported as words correct per minute, the difference between words read and number of errors. The test–retest reliability for the ORF subtest of DIBELS ranges from 0.92 to 0.97. Alternate-form reliability estimates of 0.89–0.94 across the fourth-grade level passages are reported.

Reading comprehension

To assess students' reading comprehension, we used the Passage Comprehension (PC) subtest of the WJ-IV (Schrank et al., 2014). The PC subtest is untimed, and students read cloze passages of increasing difficulty and length. Students identify one word that fits contextually in blank spaces approximately every eight words within the passage. The PC subtest has split-half reliability estimates of 0.83–0.96 for children aged 5–11 years.

Growth mindset

In prior research, Petscher et al. (2017) adapted the Student Mindset Survey (Blackwell et al., 2007) from Brainology

(Mindset Works, Inc., 2016) as a measure of students' growth mindset on the scale of fixed mindset to growth mindset. Petscher et al. modified the survey to be used with fourth-grade students. Revisions included word substitutions to increase comprehensibility for some items (e.g., substituting "smart" for "intelligent" as in "You can learn new things, but you can't really change how smart you are.") and the removal of redundant items. Students rated these items on a Likert scale ranging from 1 = disagree a lot, 2 = disagree, 3 = disagree a little, 4 = agree a little, 5 = agree, and 6 = agree a lot. Petscher et al. (2021) assessed the technical adequacy of the measure, which led to a final, adapted Student Mindset Survey that included eight general mindset items ($\alpha = .76$) and a possible range of raw scores from 8 to 48, with lower scores indicating a more fixed mindset and higher scores indicating a more growth mindset. They found a three-factor structure of growth mindset (one item), fixed mindset (one item), and effort (five items). For the present study, we used the single-item indicator of growth mindset (range of raw scores from 1 to 6), with higher scores indicating a more growth mindset and lower scores indicating a more fixed mindset.

Data analysis

Linear mixed effects (LME) models were estimated to account for the nested structure of the data with students nested in classrooms ($n = 9$). Although classrooms were also nested in schools, only two schools were in the study; thus, a simple two-level model was used. If random effects in the unconditional model were estimated at or near zero with an associated intraclass correlation accounting for less than 1% for the teacher-level variance, the random effect was removed for the conditional model to avoid matrix singularity, and a single-level model was estimated. Following the specification of the main effects and interaction models, targeted interaction terms at $p < .100$ were probed for significant differences in the estimated marginal means along the levels of predictors included in the terms. Because of the small sample, ±0.50 standard deviations were used for the pretest thresholds in simple slopes analyses. All LMEs were initially estimated using the *lme4* package (Bates et al., 2015), and single-level regressions with full information maximum likelihood (FIML) were estimated using the *lavaan* package (Rosseel et al., 2017). Hedges' *g* was computed for pretest and posttest effect sizes with omega applied to the posttest effects for the small sample correction (Hedges, 1981). Benjamini–Hochberg correction (Benjamini & Hochberg, 1995) was applied to statistically significant main effects to account for the false discovery rate.

RESULTS

Preliminary analyses

Descriptive statistics for the full sample and each subgroup are reported in Table 1. This table shows the *W* scores (for LWID, WA, and PC) or raw scores (e.g., ORF, growth mindset). It also reports TOWRE composite, which was the sum raw score from the two subtests on which students were blocked for assignment. In addition, to compare our sample of students with prior studies, we report the fall (pretreatment) standard scores for the full sample here in text: SWE ($M = 83.25$, $SD = 12.54$), PDE ($M = 85.77$, $SD = 15.57$), LWID ($M = 94.49$, $SD = 14.61$), WA ($M = 93.25$, $SD = 18.42$), and PC ($M = 83.47$, $SD = 11.90$). Thus, in fall, the full sample scored relatively lower on timed reading and comprehension measures relative to their untimed reading performance. By spring (posttreatment), the standard scores were as follows: SWE ($M = 90.20$, $SD = 14.01$), PDE ($M = 90.57$, $SD = 17.71$), LWID ($M = 94.48$, $SD = 15.48$), WA ($M = 94.05$, $SD = 17.47$), and PC ($M = 86.12$, $SD = 10.96$).

The missing data were more fully explored beyond the overall and differential attrition to evaluate missing data patterns and potential conformity to missing completely at random or missing at random. The data were

Table 1. Descriptive statistics for the full sample and by condition

	Full Sample		EMLIPS		Comparison		
Measure	***M***	***SD***	***M***	***SD***	***M***	***SD***	***g***
Fall TOWRE Sum	169.02	25.74	169.19	24.05	168.83	27.79	0.01
Fall LWID W	481.82 (94.49)	25.79	481.48	25.01	482.17	27.05	−0.03
Fall WA W	484.42 (93.25)	21.17	483.42	19.37	485.48	23.24	−0.10
Fall ORF	78.82	30.64	79.65	30.30	77.93	31.50	0.06
Fall PC W	474.07 (83.47)	15.98	475.13	14.97	472.93	17.19	0.14
Fall GM	63.77	9.26	64.95	8.65	62.45	9.85	0.26
Spring TOWRE Sum	180.77	29.90	178.48	26.57	183.21	33.39	–
Spring LWID W	487.52 (94.88)	28.37	492.48	24.16	482.21	31.84	–
Spring WA W	489.33 (94.05)	18.49	490.52	15.91	488.07	21.12	–
Spring ORF	102.75	38.34	100.87	33.88	104.76	43.12	–
Spring PC W	481.43 (86.12)	15.90	482.55	11.11	480.24	19.94	–
Spring GM	66.12	9.75	65.61	10.41	66.66	9.15	–

Note. Standard scores are provided for the full sample where available (in parentheses). *g* = Hedges *g* for baseline equivalence; GM = Growth Mindset; LWID = Letter–Word Identification; ORF = Oral Reading Fluency; PC = Passage Comprehension; TOWRE Sum = Test of Word Reading Efficiency Composite, W = W-score; WA = Word Attack.

missing completely at random, χ^2 (13) = 5.49, $p < .963$; thus, FIML was used in the estimation of coefficients within the mixed models to account for the missingness. Mean performance across the measures showed increases from fall to spring across all reading and mindset measures in the full sample and within each of the EMLIPS and BAU groups. Small, practically important differences in baseline performance (What Works Clearinghouse, 2020) were observed between the EMLIPS and BAU groups (Hedges' *g* range = −0.10, 0.26). Correlations among measures (Table 2) ranged from −.01 between fall WA and spring growth mindset to .85 between fall LWID and ORF, as well as spring TOWRE composite and ORF.

Main effect and moderation results

Unconditional LME results showed that the intraclass correlations for the classroom level by spring outcome were 12.4% (TOWRE composite), 5.9% (ORF), 2.3% (LWID), 0% (PC), and 0% (growth mindset). As a result, LME models were used for the main effect and moderation models for LWID, TOWRE composite, and ORF, whereas single-level regressions were used for PC and growth mindset. Results for the main effect analyses are reported in Table 3, where a significant effect for EMLIPS was observed after the Benjamini–Hochberg correction on LWID (10.76, $p = .008$). No other statistically significant effects were observed. Hedges' *g* by outcome using adjusted means were 0.38 (LWID), 0.15 (WA), 0.07 (PC), −0.12 (ORF), −0.16 (TOWRE composite), and −0.22 (growth mindset).

Exploratory moderation results (Table 4) showed significant interaction terms for growth mindset by EMLIPS for the TOWRE composite (−1.53, $p < .001$) and ORF (−1.87, $p = .002$). However, estimated marginal means associated with condition (EMLIPS and BAU) and fall growth mindset ($M = 0.50$, $SD = -0.50$) in Table 5 indicated that no significant differences were observed between EMLIPS and BAU at different levels of fall growth mindset for each of the spring ORF and TOWRE outcomes.

DISCUSSION

Improving reading outcomes for struggling readers remains an important public health challenge. The primary purpose of our study was to examine the effects of a reading intervention with embedded mindset training, EMLIPS, relative to a BAU comparison

Table 2. Correlations among measures for the full sample

Measure	1	2	3	4	5	6	7	8	9	10	11
1 Fall TOWRE Sum	1.00										
2 Fall LWID	0.79	1.00									
3 Fall WA	0.63	0.63	1.00								
4 Fall ORF	0.83	0.85	0.63	1.00							
5 Fall PC	0.58	0.71	0.47	0.70	1.00						
6 Fall GM	0.35	0.37	0.01	0.38	0.45	1.00					
7 Spring TOWRE Sum	0.83	0.81	0.68	0.84	0.60	0.22	1.00				
8 Spring LWID	0.74	0.79	0.52	0.78	0.70	0.33	0.73	1.00			
9 Spring WA	0.79	0.80	0.61	0.76	0.69	0.28	0.77	0.83	1.00		
10 Spring ORF	0.70	0.79	0.59	0.84	0.63	0.22	0.85	0.65	0.68	1.00	
11 Spring PC	0.47	0.65	0.45	0.59	0.70	0.23	0.52	0.83	0.60	0.56	1.00
12 Spring GM	0.20	0.23	–0.01	0.22	0.27	0.43	0.14	0.23	0.19	0.18	0.18

Note. GM = Growth Mindset; LWID = Letter-Word Identification; ORF = Oral Reading Fluency; PC = Passage Comprehension; TOWRE Sum = Test of Word Reading Efficiency Composite; WA = Word Attack.

of typical school services on reading and mindset performance. As a consequence of the pandemic, our study differed somewhat than our original preregistered study, extending prior work by Wanzek et al. (2020). For example, the intervention was delivered as a one-to-one tutorial presented virtually and our sample was relatively small, which left us underpowered in our moderation analyses. We did observe those few students in the BAU who received additional reading instruction beyond typical Tier 1 core instruction. Observations of the BAU suggested that a low proportion of time was spent on reading instruction (about 1% of time) other than grammar instruction (52% of time), and the remainder of observed instructional time was nonacademic (e.g., transitions, logging onto computers, free time on the computer). Another purpose was to learn whether students' initial growth mindset predicted their response to intervention. Taken in the context of disruptions to the 2020–2021 school year, the very modest reading growth reported by large national studies (e.g., Kuhfeld et al., 2022), and the decline in average reading scores for 9-year-olds reported by the NAEP Long-Term Trend Assessment (NAEP, 2022), one positive descriptive result is that overall, the fourth graders in our study did not decline but showed some overall improvement on standard scores, particularly on timed measures, across the school year. The full sample improved their sight word efficiency and phonemic decoding from 83.25 to 90.20 and 85.77 to 90.57, respectively. They also increased the number of words read correctly per minute by 24 words, or about 1.7 words per week, which means that they remained at risk, and their reading comprehension standard score at the end of the study was also low ($M = 86.12$, $SD = 9.75$). Their growth mindset score remained stable (4.55–4.78 out of 6) and indicated a relatively high growth mindset.

Summary of findings and potential implications for research and practice

In terms of our first research question, we had hypothesized, based on the focus of the reading intervention (i.e., 65% of instructional time focused on phonemic awareness, phonics, and word reading; 20% on comprehension), that we would also find significant effects on measures of these constructs. We did find a significant effect of the EMLIPS intervention on untimed letter and word reading ($g = 0.38$). However, we found only a trend of small, positive effect sizes favoring EMLIPS relative to BAU on untimed word attack ($g = 0.15$) and passage comprehension ($g = 0.07$). Small nonsignificant negative

Table 3. Linear mixed effect models—primary impact

	Spring TOWRE		Spring LWID		Spring WA		Spring ORF		Spring PC		Spring GM	
Intercept	183.22	<0.001	481.87	<0.001	487.82	<0.001	104.82	<0.001	470.85	<0.001	63.45	<0.001
EMLIPS	−4.91	0.249	10.76	0.008	2.77	0.333	−4.81	0.378	1.05	0.718	−2.20	0.332
Fall TOWRE Sum	0.95	<0.001	0.32	0.013	0.48	<0.001	0.04	0.848	0.059	0.394	0.02	0.627
Fall LWID			0.62	<0.001								
Fall WA					0.17	0.056						
Fall ORF							1.02	<0.001				
Fall PC									0.634	<0.001		
Fall GM											0.44	0.001

Note. Cluster-level variance was 0.00 for the TOWRE, LWID, WA, and ORF analyses. GM = Growth Mindset; LWID = Letter-Word Identification; ORF = Oral Reading Fluency; PC = Passage Comprehension; TOWRE Sum = Test of Word Reading Efficiency Composite; WA = Word Attack.

Table 4. Linear mixed effect models—growth mindset moderation

	Spring TOWRE		Spring LWID		Spring WA		Spring ORF		Spring PC		Spring GM	
Intercept	183.33	<0.001	481.73	<0.001	487.79	<0.001	105.34	<0.001	466.92	<0.001	63.43	<0.001
EMLIPS	−4.21	0.292	10.77	0.011	2.55	0.377	−3.40	0.494	1.53	0.594	−2.20	0.332
Fall TOWRE Sum	1.04	<0.001	0.30	0.027	0.44	<0.001	0.13	0.437	0.08	0.235	0.02	0.633
Fall GM	0.43	0.147	−0.09	0.755	0.01	0.947	0.31	0.407	−0.06	0.786	0.44	0.633
EMLIPS × Fall GM	−1.53	<0.001	0.20	0.665	0.21	0.518	−1.87	0.002	−0.37	0.250	−0.004	0.986
Fall LWID			0.63	<0.001								
Fall WA					0.19	0.043						
Fall ORF							1.06	<0.001				
Fall PC									0.68	<0.001		

Note. Cluster-level variance was 0.00 for the TOWRE, LWID, WA, and ORF analyses. GM = Growth Mindset; LWID = Letter-Word Identification; ORF = Oral Reading Fluency; PC = Passage Comprehension; TOWRE Sum = Test of Word Reading Efficiency Composite; WA = Word Attack.

Table 5. Estimated marginal means from simple slopes analysis of fall mindset moderation

Measure	EMLIPS	Fall GM level	EMM	SE	*df*	Lower 95% CL	Upper 95% CL
Spring ORF	0	−4.63	104.12	4.22	16.00	95.18	113.07
	1	−4.63	109.38	4.62	21.02	99.78	118.99
	0	0	105.54	4.06	14.22	96.85	114.23
	1	0	102.15	3.78	11.92	93.91	110.39
	0	4.63	106.96	4.70	22.43	97.24	116.69
	1	4.63	94.91	4.15	15.61	86.11	103.72
Spring TOWRE Sum	0	−4.63	181.56	3.35	15.32	174.43	188.70
	1	−4.63	184.44	3.68	19.64	176.74	192.13
	0	0	183.54	3.23	14.03	176.62	190.47
	1	0	179.33	3.01	11.60	172.73	185.92
	0	4.63	185.52	3.73	22.45	177.80	193.25
	1	4.63	174.22	3.30	15.50	167.20	181.23

Note. CL = confidence level; EMM = estimated marginal means; GM = Growth Mindset; ORF = Oral Reading Fluency; TOWRE Sum = Test of Word Reading Efficiency Composite score.

effects favored the BAU condition for fluency ($g = -0.12$) and the TOWRE composite ($g = -0.16$) and on word reading fluency ($g = 0.15$). These trends warrant additional research with larger samples of students and with virtual and in-person delivery.

It was encouraging that EMLIPS led to improved word reading, which is an important foundational reading skill. Yet, we noted that our findings differ somewhat from the study by Wanzek et al. (2020), which compared the effects of Brainology plus LiPS reading versus LiPS reading-only intervention conditions versus BAU. The authors reported that both reading interventions yielded significantly better performance when compared with BAU on measures of nonword reading and phonological processing, with small effects ranging from $d = 0.19$ to 0.35. Unlike the present study, Wanzek et al. found no significant differences on word reading. Our present findings converge with those of Wanzek et al. for comprehension, albeit with smaller trends that also favored the intervention condition. In addition, as Wanzek et al. noted, their students' average words read correctly per minute (71.44 and 76.10) did not reach the ORF benchmark for the end-of-year on-grade level performance of 124 words correct per minute. Similarly, in spring, our total sample read, on average, 102.75 words correct per minute. It may be worth noting some differences in the study samples. For example, in the present study, 51% were English language learners compared with 14% in the study by Wanzek et al. Across both studies, all reading instruction was provided in English. Furthermore, compared with the present study, the sample of fourth-grade students in the study by Wanzek et al. was larger ($n = 361$) and had even lower initial timed and untimed reading standard scores and lower initial ORF. The pattern of our findings is consistent with prior research on reading interventions for struggling readers regarding the small positive effects for foundational skills, and they reinforce the challenge of accelerating reading fluency and comprehension for students with or at risk for reading difficulties (Al Otaiba et al., 2022a).

In the present study, we found no significant differences for growth mindset (single item; $g = -0.22$) and with a trend toward more mindset increases in the BAU. However, future work is needed because, despite our randomization, students in the BAU group started the study with higher growth mindset, which makes interpreting our findings challenging. In a prior study, Wanzek et al. (2020) cautioned that adding the Brainology mindset

intervention to the LiPS reading intervention did not lead to an improved growth mindset. They also found that the mindset total score was relatively uncorrelated with the reading measures, suggesting that the improved reading outcomes that did occur were associated with the reading interventions and not a change in mindset. Thus, in the present study, we attempted to embed more training for applying mindset specifically to reading broadly and to the LiPS intervention strategies, specifically. Our findings suggest that this did not make a measurable difference in students' mindset, at least at the end of the study; longitudinal work is needed to learn whether mindset grows over time or may mitigate summer recidivism. Further research examining whether combining these types of training is valuable could inform interventions for multitiered systems of support implementation that address not only academic but also behavioral and other social and emotional needs for students. We encourage further research with larger samples and the incorporation of a wider range of measures, particularly given the limited convergence within the existing research. For example, Lovett et al. (2021) reported significant effects of combined training that included reading and motivational strategy training to support self-efficacy and attributions for effort on a measure of reading competence. Toste et al. (2017) reported significantly higher adaptive attributions in an initial study associated with combined training of motivation and attributions for effort with reading instruction, but then Toste et al. (2019) found no significant differences on a measure of reading self-competence in their subsequent study.

Our second research question sought to learn more about whether initial mindset moderated response to intervention. We found significant moderation of initial growth mindset for the word-reading fluency and ORF outcomes, suggesting that those with an incoming fixed mindset may have benefitted more from EMLIPS, and those with higher growth mindset may have benefitted more from BAU on these outcomes. This might suggest that students who are already trending toward a growth mindset may not benefit from further embedded growth mindset work. However, we emphasize that these analyses are exploratory, and when we examined the marginal means for different levels of initial growth mindset, there were no significant differences. In addition, despite our stratified assignment to condition that was based on word reading, students in the BAU condition had higher initial growth mindset. We encourage future research to substantiate and extend our findings and to include larger samples and more moderators.

Limitations and additional directions for future research

First, although we observed intervention during the BAU condition for two of the four students reported to have received intervention support from schools, we were not able to observe Tier 1 reading instruction. However, students were randomly assigned to intervention condition, so we would expect the effects of their Tier 1 instruction to be consistent across conditions. It is possible that although our team worked with students in the treatment condition, teachers had more time to work with students in the BAU condition, yet teachers of only four students reported that they were provided with such interventions. Anecdotally, interviews with two classroom teachers revealed how difficult it was for them and for their students to pivot to online technology. They described how online learning was not consistently available for all their students due to some issues related to internet ability and stability, which is consistent with national reports about challenges schools and families faced during the pandemic (e.g., Kuhfeld et al., 2022). Although we found that students' engagement during intervention was high, the teachers we interviewed reported that, regardless of where students were learning (school or at home), they were concerned about their motivation and attention and they reported a regression in social and emotional and academic learning related to the pandemic.

Second, although we carefully trained our staff and they indeed implemented EMLIPS with a high degree of adherence, highly rated quality, and a high degree of student engagement, the overall dosage was less than intended. On average, students in the treatment condition received 41 virtual sessions ($SD = 23$), compared with 73.5 sessions for LiPS in the study by Wanzek et al. (2020). We experienced challenges related to schools shutting down during the school year due to the COVID pandemic and due to snowstorms at both sites that closed schools and disrupted power supplies within the communities. Providing tutoring virtually was new to all our reading interventionists. Also, due to the pandemic, all assessments were administered virtually because our team was not allowed in schools. We might expect these challenges to have occurred similarly across conditions, but additional research is warranted to replicate our study under more ideal conditions with the fully intended dosage (both virtually and in person). Future research could also explore the levels of supports available from parents and other family members for those students learning from home. We echo the call of Kuhfeld et al. (2022) for further research to understand gaps in current understanding of the differential impacts of the pandemic and virtual instruction.

Third, we recruited a relatively small sample size given our intent to provide one-to-one tutoring. We did not have the power to examine potentially important moderators, including English learner status or problem behavior. Replication with larger samples and the inclusion of more students with identified specific learning disabilities, dyslexia, or speech and language impairments are needed to explore other potentially important moderators and to understand the relation between not only mindset but also other cognitive, psychological, and ecological factors (including motivation) and reading achievement (e.g., Aaron et al., 2008; Gesel et al., 2022; Kim, 2020).

Fourth, we did not assess students' oral language or their written expression (including spelling). Future research is needed that examines whether students' response to intervention is related to their oral language and listening comprehension abilities, particularly with samples that include English language learners. Describing students' oral language and written expression (particularly spelling) is another step for future research with larger samples of students with reading disabilities or at risk for significant reading problems.

Finally, we utilized a single-item indicator of growth mindset to measure mindset for the present study. The use of such a measure can result in lower precision and sensitivity in measurement. Although our own findings indicate that this may be a reliable indicator and practical for collecting data, further research is needed to validate this and other mindset measures (e.g., Duckworth & Yeager, 2015).

CONCLUSION

Overall, embedding mindset training within a virtual reading intervention for students with or at risk for reading disabilities did not seem to significantly improve student outcomes over previous studies that have implemented reading intervention and mindset training in parallel. However, some trends in student growth mindset suggest that further research exploring mindset and reading disability in intervention, perhaps in-person intervention, is needed to identify whether there are particular levels of initial growth mindset that may benefit more from an embedded mindset intervention model.

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