The Effects of a Behavioral Momentum Blending Intervention on the Accuracy of Textual and Spelling Responses Emitted by Preschool Students with Blending Difficulties

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ABSTRACT

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In 2 experiments, I tested the effects of a behavioral momentum blending procedure on the accuracy of component and composite textual and spelling responses emitted by 11 preschool students with disabilities, including autism and speech and language delays, using multiple probe designs across participants. The participants were between 3 and 4 years old and were selected to participate because they were receiving reading instruction, but they emitted low numbers of correct textual responses to words comprised of previously mastered phoneme-grapheme correspondences. Dependent measures in the experiment included blending responses to novel text stimuli, composite vocal blending responses in which no textual stimuli were used, and spelling responses. In addition, in Experiment 2, I tested the effects of the procedure on the reinforcing properties of textual stimuli. Prior to the intervention, the participants were taught to textually respond to a set of known, regular words comprised of up to five phonemic sounds represented by corresponding graphemes at a target rate (number per min). During the behavioral momentum blending intervention, participants responded to these words that were presented in rapid succession by the experimenter, followed by the immediate presentation of novel words. The experimenter provided a vocal model of the component phonemes which was systematically faded during each phase of the intervention. Results for Experiment 1 showed increases in textual, spelling, and vocal blending responses for five participants. In addition, results indicated that the participants textually responded to novel words and emitted more composite textual responses, or responses without emitting the component sounds prior to textually responding, when composite blending was modeled at the beginning of the probe session. In Experiment 2, I
altered the intervention procedure to require composite only responding as a final step in the instructional sequence. Six new preschool students were selected to participate, and the dependent measures were the same as Experiment 1; however, I also tested for the presence of conditioned reinforcement for observing print prior to and following BMBI. Results showed significant effects for four of the participants following up to two phases of intervention but were less significant for two of the participants. Additionally, results indicated the establishment of conditioned reinforcement for observing print for the participants who textually responded at criterion level. These findings are discussed with regard to the educational significance of blending as a prerequisite for textual responding and the importance of the speaker-as-own-listener verbal repertoire in learning to read phonetically.

*Keywords*: behavioral momentum, blending, speaker-as-own listener, textual responding
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Dedication

“Until I feared I would lose it, I never loved to read. One does not love breathing.”

Harper Lee, *To Kill A Mockingbird*

To my mother, for teaching me to breathe before I even knew I needed air.

Infinity much.
CHAPTER I
INTRODUCTION AND REVIEW OF THE LITERATURE

Introduction

Teaching children to read is, arguably, the preeminent goal of the American public-school system; however, it is also a goal many students struggle to attain. With the advent of the internet and the shifting technological demands of society, literacy skills are more critical now than ever before. Skills developed as early as preschool, such as oral language, print knowledge, and phonemic and phonological awareness are often predictors of an individual’s later reading success (Lonigan, Allen, & Lerner, 2011), and children who struggle with reading are more likely to struggle academically and behaviorally in school (Schenck, Fitzsimmons, Bullard, Taylor, & Satz, 1980). Difficulties with basic reading skills, such as letter-sound responding and blending, can lead to broader difficulties with reading and writing, as well as developing content knowledge, vocabulary, and fluency. Research from longitudinal studies suggests that students who are identified as at-risk in reading in first grade generally do not achieve grade-level requirements by the end of elementary school without comprehensive efforts for remediation (Francis, Shaywitz, Stuebing, Shaywitz, & Fletcher, 1996).

Given these findings, the need for applicable and evidence-based approaches to teaching reading and writing is more critical now than ever before. As the American school system continues to grow both in size and diversity, teachers are struggling to identify methods to teach all students the reading and writing repertoires necessary to thrive in post-educational settings. In the age of the internet, the communication requirements imposed on students and adults are becoming progressively more centered on reading and writing, as well. Technological advances have created an insatiable appetite for information consumption by consumers. The only way to keep up is to have essential reading skills.
Review of the Literature

Literacy

In 2000, the National Reading Panel was formed to review and evaluate the existing research and evidence related to the best methods for teaching children how to learn to read. Specifically, Congress tasked the Panel with reviewing more than 100,000 studies related to reading, identifying the most effective evidence-based methods, determining methods that were ready for use in the classroom, and formulating a plan for future research. In consideration of their review, the Panel identified five key components of effective reading instruction: 1) The instruction incorporates explicit phonemic awareness instruction; 2) The instruction involves systematic phonics instruction; 3) Instruction addresses reading fluency; 4) Instruction expands the students’ existing reading vocabulary; 5) Instruction relates to reading comprehension in addition to accurate decoding.

These components direct current trends in reading research and the educational literature, which has been equally influenced by the implementation of No Child Left Behind mandates and the subsequent push for the use of evidence-based practices in the classroom. Since 2000, some of the more recent topics from the American Educational Research Journal include the sources of reading comprehension difficulties among language minority learners (Lesaux & Kieffer, 2010), the development of gender gaps in reading achievement (Robinson & Lubienski, 2011), the impact of differentiated instruction and enrichment activities on reading outcomes (Reis, McCoach, Little, Muller, & Kanistan, 2011), and the effects of data-driven reform on performance on statewide assessments (Slavin, Cheung, Holmes, Madden, & Chamberlain, 2013). Clearly, practitioners are looking for methods to best teach an increasingly diverse
population of American students while attempting to address the reality of evolving stipulations of national and state legislation.

Despite the need for high-quality instructional strategies to teach reading skills, educators have yet to reach a consensus on the most effective strategies to employ in the classroom and the research has not provided any definitive solutions. Practitioners continue to debate between whole language and phonics instruction, for example, despite an accumulation of evidence that suggests phonics instruction is a significantly more effective and efficient method (McGuinness, 2005). Educators and theorists lament the use of Direct Instruction and other scripted curricula, arguing that these programs distance teachers from their work and from their students and emphasize mass production rather than creativity or “discovery learning” (Rumph, Ninness, McCuller, Holland, Ward, & Wilbourn, 2008). It appears that stakeholders have used irrelevant variables to filter out efficacious strategies and this discrepancy has likely resulted is less than favorable reading outcomes for children. And, the numbers do not lie. Recent reports from the National Center for Education Statistics indicated that in 2013, 65% of fourth grade students nationally performed below proficient in reading, a percentage not markedly different from that observed in 2011, suggesting that more than 15 years after the National Reading Panel (NRP) report (2000), educators are still struggling to determine how they can best teach reading.

**Phonics Instruction**

According to Baer and Row (1999), phonics instruction is a method of reading instruction based on letter-sound correspondence; students learn phoneme sounds and how to blend those sounds together to read words, also known as a bottom-up approach to reading. McGuinness (1997) argued that phonics instruction is significantly more effective and efficient than other methods, such as the “whole word” approach. Findings from the NRP report support these
claims; that is, systematic phonics instruction was found to be significantly more effective in teaching children to read than other approaches that did not involve teaching phonics. Phonological awareness, or the identification and manipulation of a variety of units of oral speech, and phonemic awareness, or the identification and manipulation of individual speech sounds in words, are both considered necessary prerequisites for phonics instruction (see Table 1).

Given the varied abilities of students learning to read in the public-school system, many different commercial interventions have been developed that incorporate a phonics-based approach into reading instruction. Responsive Reading Instruction, or RRI, is a supplemental reading intervention for low-performing readers designed to teach phonics and word recognition in addition to fluency, comprehension, and vocabulary-related tasks. Denton, Nimon, Mathes, Swanson, Kethley, Kurz, and Shih (2010) assessed the effects of Responsive Reading Instruction on first graders’ performances on multiple measures of reading, including phonological awareness, word identification, blending, phonemic decoding, and reading comprehension. Results of the RRI group were compared to a control group that received typical school practice (TSP) and demonstrated that the RRI group outperformed the TSP group on all measures except measures of phonological awareness. Further, significantly more students in the RRI group demonstrated more significant response to intervention as compared to the TSP group, including on measures of word identification, blending, and phonemic decoding. Based on these results, the authors concluded that the quality of the reading instruction may be more important than the quantity; that is, it matters what is taught more than how much time is devoted to reading instruction.
Similarly, Simmons, Coyne, Hagan-Burke, Kwok, Simmons, Johnson, Zou, Taylor, Mcalenney, Ruby, and Crevecoeur (2011) compared the effects of an explicit and systematic commercial reading program, in this case Early Reading Intervention (ERI), and typical school instruction on the reading achievement of young children. Like the RRI intervention, ERI involved multiple activities to address a range of reading skills, including phonological awareness and alphabetic understanding, spelling, and writing instruction. Lessons were scripted and highly detailed. Results showed statistically significant effects for the ERI group on alphabetic, phonemic, and, for some, on untimed decoding skills; performance did not differ significantly for advanced reading and spelling tasks. The authors suggested that, in consideration of these findings, students who are most at-risk for reading difficulties and disabilities may benefit from more explicit and systematic reading instruction, such as scripted curricula like ERI, particularly in domains related to decoding and word reading.

Twyman, Layng, and Layng (2011) tested the effects of the Headsprout® reading program, a computer-based program, on kindergarten and first grade students’ responding on reading measures related to letter-word identification and reading words. The experimenters tested for statistical significance by comparing the responses of the participants who received the Headsprout® intervention to the responses of participants in an experimental control group and applying Hopkin’s method of statistical significance. Results demonstrated that students who progressed through the program and received at least 41 lessons showed an instructionally beneficial effect on every measure as compared to the students in the control group. The authors noted that students who did not complete the Headsprout® intervention demonstrated positive effects regardless, suggesting that Headsprout® can improve reading outcomes even when students complete only a portion of the lessons.
Direct Instruction. Despite its controversy in the world of academia, one of the most widely researched phonics-based approaches is Direct Instruction, a systematic and evidence-based type of instruction that utilizes multiple exemplar instruction to build upon existing repertoires and generate novel relational frames. The model is comprised of three broad components (Slocum, 2004). First, Direct Instruction curricula are organized to teach generalizable strategies, and this underlying principle drives the content that is taught and the way in which it is organized. Second, Direct Instruction programs are designed to systematically build on existing repertoires, gradually fade performance supports, provide ample opportunities for practice, and describe teaching procedures in explicit detail. Third, the programs specify a distinct set of procedures for teacher-student interactions and maximize active learning and student engagement. Direct Instruction curricula for reading typically target phonological skills, phonics development, whole-word instruction for high frequency irregular words, and oral reading. With regard to phonetic reading, for example, these curricula teach students to listen to the component phonemes in a word and “say it fast” to blend those sounds together to read the word (Engelmann & Carnine, 1982); or, in other programs, students must say the sound for each phoneme on an instructor’s signal, then read the word as the instructor slides his or her finger underneath it. Many of the direct instruction and other explicit reading programs progress from teaching students to identify and read individual phonemes to teaching them to blend the phonemes together into smaller units of decodable text (Engelmann & Carnine, 1982). The curricula provide frequent opportunities for assessment of production and selection responses, and these assessments can be used, in turn, to determine appropriate grouping and the potential need for re-teaching (Slocum, 2004).
Direct Instruction has an impressive research base that dates back over several decades. Project Follow Through was one of the first studies to compare the effects of Direct Instruction curricula with other instructional models. The massive study was conducted with over 10,000 students between 1968 and 1976 and investigated outcomes related to word recognition, spelling, and reading comprehension, as well as repertoires from other academic domains, across nine different instructional approaches. Out of all the approaches, results showed that Direct Instruction was the only one of the nine models with consistently positive effects. That is, “Direct Instruction outcomes were vastly superior to all of the other models” (Slocum, 2004, p. 92).

The effects of Direct Instruction curricula related to teaching reading have been the focus of several specific studies. Carlson and Francis (2002) assessed the effects of the Rodeo Institute for Teacher Excellence (RITE) which was designed to assist at-risk readers in kindergarten to second grade. The experimenters administered subtests from the Woodcock Reading Mastery Test-Revised and TRPI tests related to letter-sound identification, blending, and phonological awareness to evaluate the effectiveness of the program, which incorporated the Reading Mastery® curriculum, phonics instruction, and relevant professional development opportunities for teachers. Overall, authors found that the program resulted in positive effects across outcomes as compared to results for the participants who comprised the control group, and, more specifically, positive effects were particularly significant in earlier grades and for students who had participated in the program since kindergarten. In this sense, the Direct Instruction program and simultaneous teacher training accelerated the development of reading repertoires for elementary-aged participants, as students who received the treatment package continued to outperform their peers up to two years later.
Shippen, Houchins, Steventon, and Sartor (2005) compared the effects of two Direct Instruction reading programs on reading achievement of struggling readers in seventh grade. One program, REWARDS, emphasized the use of overt reading strategies, while the second program, Corrective Reading, focused on the development of covert strategies when learning to read and respond to textual information. Regardless of the curricula used, significant improvements across all dependent measures were observed; however, a more substantial effect was noted for the students who placed into the higher Corrective Reading group. The authors contended that direct instruction is a promising instructional model that can improve reading skills for all learners, but that the model may have a greater benefit for students who possess the necessary, albeit unspecified, prerequisite repertoires.

Other studies have investigated potential benefits of redesigning direct instruction curricula for beginning readers. Prager (2008) compared the effects of a linearly sequenced direct instruction curriculum and a spiraled direct instruction curriculum on the number and rates of emergent textual responses emitted by six preschool students. For the spiraled curriculum, Prager re-sequenced the Reading Mastery® curriculum such that increasingly complex letter strands of interrelated phonemes were introduced earlier on in the instructional sequence, and fewer single-phonemes were emphasized in the initial lessons, as they were in the linear instructional sequence. In this sense, the importance of teaching blends for strands of up to four letters superseded the introduction of novel one to two letter phonemes. Prager (2008) found that students who completed the spiraled sequence demonstrated a greater number of emergent textual responses and better maintenance of blending over time than the participants who completed the linear sequence. All other aspects of the curriculum delivery remained the same for participants across both conditions.
Despite Prager’s findings that direct instruction curricula can be reorganized to better teach the blending abstraction, these types of programs provide few, if any, remedial options for students who fail to blend even after receiving an extensive number of exposures to the lessons, no matter the sequencing design. For these students, instructors must investigate alternative options derived from the research and other evidence-based approaches.

**Blending and segmenting.** Activities that develop phonological awareness have been linked to positive outcomes in reading achievement (McGuiness, 2005). Children who have difficulty manipulating the 44 phoneme sounds that comprise the English language are at a significant risk for reading failure, and skills involved in letter-sound association and using sounds to read words are strong predictors of future reading success (Daly III, Chafouleas, Persampieri, Bonfiglio, & LaFleur, 2004). Segmenting and blending individual speech sounds, in both the presence and absence of corresponding printed letters, are commonly cited phonics-based approaches that can enhance phonological awareness and phonics skills (Daly et al., 2004; McGuinness, 2004; 2005; Weisberg & Savard, 1993). The phenomenon of blending involves joining together phonemes that are represented by graphemes to read printed words; individuals are taught to “sound out” the words by saying the component sounds without stopping (McGuinness, 2005). Segmenting involves sequentially separating phonemes as they correspond to graphemes in a word; unlike blending, segmented units are emitted with silent pauses between them. To acquire a complete reading repertoire, students must learn to segment and blend together component phonemes (as represented by graphemes) into words (see Table 1).

Despite the increasing emphasis on phonics-based approaches to reading related to blending and segmenting, phonics advocates have yet to agree on how these processes should be taught or carried out (Weisberg & Savard, 1993). For instance, in some phonics-based programs
segmented units are emitted with pauses of unspecified durations, to demonstrate that words are comprised of divisible parts. However, critics of this approach argue that pausing may make it difficult to later recombine or blend the component sounds together to read the composite word. Direct Instruction curricula reconcile both approaches by requiring students to segment sounds slowly, then blend the sounds together to textually respond to the composite word.

There are inconsistencies in the research related to which units should be taught for accurate blending to occur, as well. Martens, Werder, Hier, and Koenig (2013) argued that generalization and fluency occurred more rapidly when vowel “teams,” or, more accurately, vowel digraphs, were taught directly. Second grade students were taught to blend phonemes in a small set of words containing three target vowel teams; results demonstrated that when the vowel digraphs were trained to a fluency criterion, the students textually responded to novel words that contained those digraphs, and oral reading fluency improved. Other approaches suggest that the minimal unit should consist of phoneme-grapheme correspondences at the single sound level. Daly III et al. (2004) found that students textually responded to novel words more accurately when they were taught to segment each individual phoneme while observing the corresponding grapheme, than they did when larger units were taught.

In addition, the mode in which these phonics activities are taught varies in the literature. For instance, Ayala and O’Connor (2013) investigated the effects of a video self-monitoring intervention on first grade students’ decoding and sight word recognition skills. Findings showed that all the participants demonstrated improvements on the decoding and sight word recognition measures, yet limitations related to repeated reading were a significant confound to the reported results.
**Spelling.** Phonological awareness and letter-sound knowledge work together in the acquisition of accurate spelling repertoires, as well (Ehri, 1989). Spelling and reading are often considered to have a reciprocal relationship, whereby one process informs the other (Ehri, 2000). The establishment of an accurate reading repertoire helps to establish an accurate spelling repertoire, and vice versa.

Ehri (1989) suggested that people use three sources of information when learning to spell words: letter knowledge, knowledge of the spelling system, and lexical knowledge, which involves knowing how letters represent phonemes and how these letters should be sequenced to form words. Moreover, learning to spell may be an incremental process in which young readers and writers gradually advance through different stages as their knowledge of letter names and letter-sound relationships develops. Evidence for this hierarchical development of spelling skills exists in samples of young students’ writing; while their letter choices are often erroneous at first, the choices are logical. Early on, letter names may serve as substitutes for sounds when selecting letters, and as their knowledge of the phonetic system grows, the spellings may contain letters that represent the sounds in words, including extra sounds not represented in the actual spelling but evident in the pronunciation of the word (Ehri, 1989).

Research related to spelling has received heightened attention in the past several decades. The bulk of the research considers only the correctness of responses, despite evidence that accurate spelling is acquired in stages, parallels the child’s reading proficiency, and may represent other phonological skills (Kroese, Hynd, Knight, Hiemenz, & Hall, 2000). Previous research has concentrated on phonetic aspects of spelling (Snowling, Stackhouse, & Rack, 1986) as well as visual aspects (Bruck & Waters, 1988) and spans a range of ages and levels of

Boder (1973) analyzed spelling errors in children with disabilities and identified three specific types of errors: difficulty sounding out words, difficulty seeing the whole word, and difficulties with both. Later studies used scaling systems to analyze errors, including errors that could be considered “phonetic” or “nonphonetic” (Fischer, Shankweiler, & Liberman, 1985) as well as specific phoneme-grapheme errors (Invernizzi et al., 1989). Kroese et al. (2000) used an eight-point scaling system to analyze spelling errors emitted by children with and without disabilities and the relationship of the errors to phonemic and phonological awareness skills. Results demonstrated that students with disabilities made more phonetically inaccurate errors than their non-disabled peers.

Given the research, there are several implications for spelling instruction. According to Ehri (1989), students should be taught letter names and sounds before reading and writing instruction begins, and once acquired, “inventive” phonetic spelling should be encouraged, at least initially. As students begin to spell phonetically, teachers can teach them how to detect additional sounds in words. As with reading instruction, spelling instruction requires explicit and systematic teaching of component skills; students are more equipped to identify and recombine the sounds in words following direct instruction.

**Textual Behavior**

In *Verbal Behavior*, Skinner (1957, p. 185) defined textual behavior as having “point-to-point correspondence between properties of stimulus and response” without formal similarity; that is, although the spoken sounds in a word correspond to the printed symbols that represent the word, the form of the stimulus (printed word) and the response (spoken word) are not the
same. For the purposes of this review, textual responding is best understood as reading or reader behavior (see Table 1). Skinner described the development of a textual repertoire as occurring through the acquisition of minimal units, which, once acquired, could be recombined into novel and more complex units. Skinner suggested that point-by-point correspondence exists between the properties of the textual stimulus and the individual’s textual behavior (Skinner, 1957) and that just as individuals acquire echoic responses that vary in length and complexity, the acquisition of minimal textual units varies, as well. Textual responses can be taught through phoneme-grapheme correspondences, at the whole word level, or even through phrases and sentences. Skinner contended that through the acquisition of these minimal units, individuals learn to induct sounds from textual responses; that is, the individual comes to develop a small repertoire of textual responses.

The acquisition of these minimal units is critical in learning to read and respond to textual stimuli, even though these units are often not direct instructional targets, nor do they frequently appear in isolation. However, these units make novel textual behavior possible. For example, once an individual can respond to a subset of phoneme-grapheme combinations, he or she can see a novel combination of known graphemes and sound them out to produce the blended word. Initially independent observing and producing responses join when individuals emit textual responses through blending.

Skinner’s treatment of textual responding has important implications for teaching reading repertoires. If minimal units, in this case phoneme-grapheme combinations, are taught, these units can be recombined, or abstracted, to generate novel and more complex combinations, at the word or even phrase and sentence level. Therefore, by directly and systematically teaching phonemes, and phoneme-grapheme units, students can learn to textually respond to a range of
larger textual units. In this sense, Skinner’s approach prescribes a potential sequence for
designing curricula and instruction. Although perhaps not intentionally, Skinner proposed a
method for how operants can be acquired and recombined to form more complex reading
repertoires.

Component and Composite Repertoires. Skinner’s contribution of the minimal unit has
been considered by other behaviorists in the field, as well, including educational behaviorists; for
example, his analysis is evident in theory and research related to generative instruction. Alessi
(1987) argued that instructional approaches in education that emphasized rote learning over
generalization are considerably less effective, as it is impossible to teach every stimulus-response
relation that comprises a complex repertoire. According to Alessi, generalization involves the
acquisition of novel stimulus-response relations without direct teaching, and for abstract control
to emerge, the individual must learn to respond to the essential features of the target stimuli,
including target stimuli which vary considerably in their irrelevant dimensions. Alessi referred to
Skinner’s minimal response repertoires, which, once acquired, can be arranged to occasion
derived stimulus-response relations; further, although only a small number of minimal units may
be directly taught, the universal set, comprised of all the various combinations of stimulus-
response elements, may be infinite. In the case of establishing minimal textual responses, an
individual may “be able to decode 10,000 novel words for each discrete sound-symbol element
taught” (Alessi, 1987, p. 18).

Johnson and Layng (1992) considered the role of generative instruction in their
development of the Morningside Model®. Skills taught in the model are comprised of
component and composite skills, as well as the establishment of “underlying tool elements to
fluency.” When fluent component skills are developed and subsequently called upon with new
environmental requirements, these behaviors recombine into novel, higher-level responses. One goal of the generative nature of the instructional sequence is contingency adduction, whereby a set of repertoires initially shaped under one set of conditions is recruited under a different set of conditions for a different function, and a new repertoire emerges. In the case of textual responding, training a set of phoneme-grapheme correspondences to fluency may lead to novel textual responses of larger units of text, such as words. However, there may be other repertoires that need to be trained before a fluent textual responding repertoire is acquired.

**Stimulus equivalence.** Sidman’s contribution of stimulus equivalence was one early and critical theory that could be integrated with Skinner’s treatment of behavior. Here, Sidman (1994) suggested that a basic stimulus function can be explained by the ontogenetic history of humans. When an individual learns a series of related conditional discriminations, the stimuli become related to each other in ways that were not directly taught or trained. Stimulus equivalence consists of three properties: reflexivity, symmetry, and transitivity. Reflexivity requires that each stimulus be matched to itself (i.e. Given A1, select A1; Given B2, select B2, etc.). Symmetry requires that the sample comparison relation taught during training must be reversed (given A1 to select B1, given B1 the individual must select A1). Transitivity requires three stimuli, such that a trained relation between two of the stimuli combines with a relation between one of those stimuli and a novel stimulus, so that an untaught relation emerges with the initial stimuli and the novel stimulus (i.e. training A1 select B1, and B1 select C1, the individual should select C1 in the presence of A1 as well).

Stimulus equivalence has contributed to reading and writing research about sight word recognition (Kennedy, Itkonen & Lindquist, 1994), matching printed words to spoken words (Mueller & Olmi, 2000), and spelling (de Rosa, de Souza, & Hanna, 1996). Kennedy et al.
(1994) tested for symmetry and transitivity at two levels with sight words derived from the four food groups. Three participants with moderate disabilities were taught A-B, B-C, and C-D conditional discriminations for each of the potential stimulus classes. Results demonstrated equivalence formations for symmetry, then transitivity, in that order. However, the authors noted that the emergence of untrained relations did not necessarily indicate the formation of a stimulus class, and that additional training may be necessary before the “concept” (i.e. abstraction) is fully mastered.

De Rosa, de Souza, and Hanna (1996) tested the effects of an exclusion training procedure on the emergence of taught and untaught reading, comprehension, and spelling responses emitted by elementary-aged, nonreading children in two experiments. In Experiment 1, seven children participated, and in Experiment 2, four different children participated; all the children were selected to participate due to referrals from their classroom teachers indicating they had difficulty learning to read and spell simple words. During intervention, the experimenters taught the participants to match printed words to dictated words and, in Experiment 1, to construct printed words using movable letters and read the words. The constructed response component was eliminated in Experiment 2. All the participants learned to read and spell the training words in both experiments, and in the first experiment, five of the seven participants demonstrated generalization. Only one of the participants read and spelled generalization words with significantly more accuracy in Experiment 2, suggesting that the word construction component may have facilitated generalization for reading and spelling novel words. In a replication study, Mueller and Olmi (2000) tested the effects of a spoken-to-printed match-to-sample (MTS) training procedure on textual responses demonstrating recombinative generalization of within-syllable units emitted by preschool children who were learning to read.
The participants were taught to match spoken words to printed words using sets of words that had overlapping letters and syllables to “generalization” words used in the pre- and post-tests. Results showed that the participants who received the intervention matched more novel spoken words to printed words and textually responded to more novel words than the participants in a control group. Equivalence classes were formed between pictures, the spoken words, and the printed words for the participants.

Matos, Avanzi, and McIlvane (2006) tested for the emergence of equivalent relations between pictures, spoken words, and printed words with 16 low-SES Brazilian children. Participants were taught to select pictures that corresponded to spoken words, select printed words with a target syllable at the beginning or end of the word in response to a visual or auditory presentation of the syllable, construct words that corresponded to a spoken word by arranging component syllables, and construct words that corresponded to printed words. The findings demonstrated that when participants completed the first two tasks, they responded to all the target tasks as well as textually responded to novel words comprised of the target syllables. In sum, these studies highlight the significance of teaching relational stimulus control as a component of reading instruction.

Relational frame theory. Later, Hayes, Barnes-Holmes, and Roche (2001) developed Relational Frame Theory to further address the complexities of language development not encompassed by Skinner’s theory or the subsequent work related to stimulus equivalence. Relational frame theorists define verbal behavior as arbitrary stimulus relations that occur during relational responding, or responses emitted within a frame. Like Skinner’s three-term operant, relational frame theorists conceptualize relational responses as three-term contingencies, with contextual cues functioning as the third term in the contingency, and the history of differential
reinforcement associated with the contextual cue functioning as the first term. For this reason, derived relational responding has been considered generalized operant behavior (Healy, Barnes, & Smeets, 1998).

Relational Frame Theory has extended to a range of academic disciplines, including reading instruction. For instance, in two experiments, Healy, Barnes, and Smeets (1998) taught four individuals to textually respond to a set of nonsense syllables comprised of three phonemes as evidence of derived relational responding. Specifically, the experimenters conducted probes for derived relations of combinatorial entailment, or combined symmetry and transitivity, for groups of participants who received accurate feedback as compared to groups who did not. Results demonstrated that derived relational responding was controlled by differences in contingent consequences; that is, the group of participants who received the accurate feedback responded more accurately than those who did not receive accurate consequences. A subsequent set of experiments improved on the shortcomings from this initial experiment by controlling for Type R (reject) versus Type S (select) relations by incorporating four different types of relations such that the experiment involved fewer Type R (reject) relations. The findings showed that participants who received contingent response feedback were more likely to demonstrate derived relational responding, and, more likely to demonstrate mutual and combinatorial entailment. Subsequent experiments yielded similar effects.

Smeets, Leader, and Barnes (1997) examined the effects of different training protocols and training and testing arrangements on the formation of conditional discriminations and equivalence classes. Different training protocols included a linear protocol, a one-to-many training protocol with conditional stimulus relations, and a many-to-one training protocol with equivalent relations. Testing as well as training arrangements were either conducted
simultaneously or in a simple-to-complex format. Results indicated that adults acquired target discriminations and equivalent classes most efficiently when training protocols and arrangements involved the many-to-one and simultaneous procedures. In contrast, children responded more accurately to the simple-to-complex procedure, substantiating the argument that a bottom-up approach may be more effective in teaching the foundations of textual behavior and the minimal units necessary to develop reader behavior.

There are several important distinctions between Sidman’s theory of stimulus equivalence and Relational Frame Theory. For example, stimulus equivalence differs from Relational Frame Theory in that Sidman argued that equivalence precedes the development of language whereas Hayes argued that language and equivalence represent the same derived process. Equivalence is one relation, referred to in RFT as frames of coordination; however, Sidman viewed it as the most important relation. Regardless, both theories emphasize the importance of teaching and fostering equivalent relations when designing reading instruction and offer important additions to Skinner’s work and the expanding research base related to textual behavior.

**Verbal Behavior Development Theory**

Over the past 20 years, research related to the ontogenic development of language has substantiated Skinner’s (1957) initial hypothesis on how an individual comes to acquire verbal behavior functions. Taken together, this body of literature suggests that verbal individuals learn their behavior from a sequence of developmental experiences in which independent listener and speaker responses are acquired and integrated, over time, within the individual to produce higher order classes of rotated selection and production responses, such as speaker-as-own-listener, reader, and writer repertoires (Greer & Speckman, 2009). The accumulating evidence indicates
that the sources of many of these developmental stages may be the acquisition of conditioned social reinforcers. Building on definitions provided by Rosales-Ruiz and Baer (1996, p. 166), these conditioned social reinforcers constitute “behavioral cusps” without which “little or no further development is possible” and bring the individual “into contact with other cusps crucial to further, more complex, or more refined, development.” In other words, behavioral cusps make it possible for the individual to learn that which he or she could not learn prior to the emergence of the cusp. Recent literature suggests that a sub-class of cusps may exist that allow the individual to learn in new ways, as well as advance his or her progression through the verbal developmental stages. These specialized cusps are referred to as capabilities.

For many children, these cusps and capabilities may come to be acquired through a cumulative history of experiences with specific environment-behavior interactions. However, for children with disabilities or those with a limited number of language experiences like the children described by Hart and Risley (1995), these repertoires may not be naturally acquired through incidental experiences. For these children, there must exist other teaching technologies that can replicate these formative experiences to advance the child’s verbal behavior development. The CABAS® (Comprehensive Application of Applied Behavior Analysis to Schooling) system offers one such approach to teaching and inducing these verbal behavior developmental milestones (Greer, 2002), by applying Verbal Behavior Development Theory, or VBDT, to all aspects of instruction.

The listener repertoire. The role of the listener has received considerable attention in the behavior analytic community over the past decade, including within VBDT, although early research on the significance of listener behavior can be traced back to Skinner’s *Verbal Behavior* (1957). While Skinner was concerned primarily with the development of speaker behavior, he
recognized the importance of listener behavior and specifically, its relationship with the acquisition of speaker repertoires. Specifically, Skinner (1957) suggested that an individual must be under the control of the auditory properties of vocal stimuli, or another individual’s speaker behavior, to acquire true vocal, verbal behavior of his or her own.

As identified by Greer (2002), a listener is an individual who engages in verbally governed behavior, behavior including compliance with vocal instructions and tracking tasks; that is, listeners are under the control of the vocal sounds and other verbal topographies of a speaker. Moreover, the acquisition of a listener repertoire signifies the point at which an individual first acquires more independence because he or she can profit from being told information (Greer, 2002; Greer & Ross, 2008). Individuals with listener behavior no longer require direct physical contact to complete activities of daily living; rather, physical contact is replaced by the verbal behavior of a speaker, to which the listener responds.

Research suggests that a functional listener repertoire can be critical to the acquisition of higher order verbal operants, findings that are consistent with Skinner's initial argument (1957). Lodhi and Greer (1989), for example, found that children acted as their own listeners and speakers when engaging in play with anthropomorphic toys. Data showed that the children rotated the roles of listener and speaker during their play, emitting conversational units within the individual, and exhibiting what is otherwise referred to as self-talk. This self-talk provided an observable measure of the listener role and its relationship to the speaker role and served as a basis for investigating speaker-as-own-listener cusps.

**Speaker-as-own-listener and reader behavior.** The relationship between speaker and listener behavior, both behaviors emitted between individuals as well as within the skin, impacts the development of reader behavior. For example, in the case of a child who is learning to
textually respond out loud in the presence of a listener, the child functions as the speaker and the listener mediates his or her behavior (Mercorella, 2017). If the child textually responds to the graphemes in the word by blending together their corresponding phonemes to produce the word, and the listener provides reinforcement, the child is more likely to emit that same response in the presence of that textual stimulus in the future. The mediation of a listener allows the reader to acquire essential stimulus control and derive relations between spoken words and printed text (Mercorella, 2017).

Lyons (2014) argued that blending component sounds to produce novel words, as well as segmenting component sounds from composite words, are both examples of speaker-as-own-listener behavior as it relates to the establishment of reader repertoires. To blend sounds together to read a whole word, the novice reader must first learn to listen to his or her own speech sounds when responding to the graphemes in the word, thereby listening while also responding as a speaker. Lyons (2014) investigated the benefits of an auditory matching of component speech sounds to composite words intervention on textual responding and spelling of words for preschool and elementary-aged students. During intervention, participants were required to match component speech sounds to words and vice versa using an auditory matching program on the computer. The intervention consisted of ten total phases, with each phase increasing in complexity and addressing different phoneme patterns and word lengths. Results showed that following the intervention, the participants not only textually responded with greater accuracy, but could spell target words with increased accuracy as well. Further, the participants’ rates of learning in reading instruction were accelerated; specifically, the number of learn units required to master textual responding objectives decreased significantly following the intervention. Based on these findings, Lyons (2014) suggested that various levels of speaker-as-own-listener
responding may be required when learning how to read. She proposed that individuals may need to learn to respond to their speaker behavior at the overt level, by emitting the component phonemes in the word, prior to engaging in this behavior at the covert level and emitting the composite word only.

Hill-Powell (2015) investigated the role of speaker-as-own listener behavior in silent reading and accuracy answering comprehension questions related to the text. In her first experiment, she compared the reading rates and text comprehension of adults and elementary-aged students in two conditions: reading aloud and silent reading. Results showed that adults read more fluently and with more accurate reading comprehension when they read silently. In Experiment 2, Hill-Powell tested the effects of a treatment package designed to teach third grade participants to read silently with reading comprehension. During intervention, progression up a peer-yoked contingency game board was contingent on silent reading and accurate responses to comprehension questions for both participants in the pair. Results indicated that all the participants acquired silent reading with comprehension following the intervention. Based on her findings, Hill-Powell argued that reading covertly with comprehension was an essential speaker-as-own-listener repertoire that could have both important academic and social implications. Students who were lacking the repertoire may have been missing a critical component that prevented them from acquiring an effective and fluent reading repertoire.

Speaker-as-own-listener behavior has been critical in the establishment of other repertoires related to reading, too, like spelling. Greer, Yuan, and Gautreaux (2005) tested the effects of multiple exemplar instruction across written and spoken responses in instructional sets on the acquisition of untaught spelling responses in vocal or written form for four young children. Probe data showed that following multiple exemplar instruction that rotated across
written and spoken responses, the participants emitted untaught responses to a novel set of words. Greer et al. (2005, p. 111) proposed that multiple exemplar training “produced a joint stimulus function for both responses to novel words taught as a single response.” This phenomenon could be characterized as a higher order class of behavior, or a relational frame.

**Establishment of conditioned reinforcers related to reading.** Verbal Behavioral Development research includes many studies related to the acquisition of fluent reader behaviors and how these responses are tied to the acquisition of new conditioned reinforcers. The theory also considers the establishment of repertoires that may function as critical prerequisites for such behavior (Greer & Ross, 2008). One critical cusp for individuals with pre-listener repertoires is the acquisition of conditioned reinforcement for attending to two-dimensional (2D) print stimuli. Keohane, Delgado, and Greer (2009) contended that a child’s observing responses constitute the foundation for the development of early behavior repertoires. When attending to, or observing, visual stimuli does not function as a conditioned reinforcer for a child, the child fails to derive necessary relations between what he sees and what he hears. In the case of observing 2D print stimuli, the lack of such a correspondence can have serious implications in learning more complex verbal skills, including generalized matching and making even the most salient discriminations between two-dimensional stimuli; textual behavior is likely impossible.

Keohane et al. (2009) tested the effects of a stimulus-stimulus pairing procedure on the establishment of conditioned reinforcement for observing 2D print stimuli. During intervention, the experimenters alternated between pair trials, in which known reinforcers were delivered as the participant observed 2D stimuli, and test trials, in which no reinforcement was provided. Dependent measures included the duration that the participants observed pages with novel printed 2D stimuli; if participants looked at four out of five pages for at least 10 s each, the
experimenters considered conditioned reinforcement for observing 2D print to be present. Following establishment of the cusp, all the participants required fewer instructional trials, or learn units, to master objectives related to matching print stimuli.

As argued in the VBDT literature, one of the first developmental milestones directly related to reading is the acquisition of conditioned reinforcement for observing books. Once present, conditioned reinforcement for books has been linked to positive outcomes in reading and acquiring novel textual responses. Tsai and Greer (2006) tested the effects of the acquisition of conditioned reinforcement for observing book stimuli on the number of learn units required to master textual responses for four preschool-aged participants. The experimenters divided participants into dyads and conditioned books as reinforcers for observing responses using a stimulus-stimulus pairing procedure for one participant in each pair until books became the preferred free-play activity. The experimenters implemented a toy conditioning procedure for the other participant in each pair. Results demonstrated that all the participants required fewer learn units to master textual responses once books were conditioned as reinforcers for observing responses. Additionally, three out of the four children maintained a preference for books as demonstrated during the one-month follow-up probes. These findings were later substantiated in Buttigieg’s (2015) dissertation which found that once book stimuli selected out individual observing responses, rate of acquisition of novel textual responses was accelerated. Buttigieg (2015) demonstrated similar effects across 16 preschool participants using a variety of conditioning procedures as well.

In three experiments, Moore (2017) evaluated the effects of conditioned reinforcement for reading content on the reading comprehension of fifth grade students. Conditioned reinforcement for reading content was measured using observation data; participants who were
observed to read for 80% of the 10 s whole intervals recorded during a 20 min observation were considered to have conditioned reinforcement for reading. Results of the first two experiments demonstrated that reinforcement value was directly related to standardized test outcomes; further, conditioned seeing and derived relational responding were prerequisite repertoires for the establishment of conditioned reinforcement for reading content. In her final experiment, Moore (2017) tested the effects of a peer yoked contingency game board on the establishment of reinforcing value for reading content. Results showed that when the reinforcement value of reading increased, participants increased their grade level equivalency on standardized reading assessments of comprehension, from a range of 0.7 to 3.8 in just four weeks. Moore (2017) argued that conditioned reinforcement for reading content may constitute a behavioral cusp in that an individual’s exposure to novel textual stimuli increases as the reinforcement value for attending to the text increases; the individual can access information he or she could not prior to the change, thereby learning in a new way. In this sense, conditioned reinforcement for reading content makes it possible to learn new operants.

**Behavioral Momentum**

Other than the studies outlined herein, there is little research from educational behaviorists related to the significance of blending instruction in learning to read. However, in recent years, educators have increasingly looked to behavior analysts for answers in solving issues in the classroom. Behavioral momentum, for example, is one commonly applied principle of behavior used in educational settings.

Nevin (1992), who identified the phenomenon, characterized behavioral momentum as the product of two critical components: rate of responding and resistance to change. Rate of responding can be linked back to Thorndike’s (1913) law of effect, he argued, whereby
reinforcement strengthens the relationship between an antecedent stimulus and a response such that the probability of a subsequent response in the presence of that stimulus increases. This principle continues to be evident in modern free operant research; the contingency between reinforcement and responding affects the future rate of responding. In addition, Nevin (1992) contended that the stimulus-reinforcer relation governed a response’s resistance to change. He likened this theory of behavioral momentum to Newton’s second law of motion, and the relation between velocity and mass (Nevin, 1992). Much like physical mass that when in motion will remain in motion until acted on by an external force, behavior that is maintained by steady rates of reinforcement will continue until there is interference from some external variable. Ray, Skinner, and Watson (1999) expanded on this definition, defining behavioral momentum as the “use of a series of high-probability requests to increase compliance with lower probability requests;” that is, ongoing behavior tends to persist, even in the presence of an environmental change. Essentially, behavioral momentum is a behavioral strategy that involves presenting tasks that are easier for an individual to perform before presenting tasks that are more challenging or difficult and less likely to be performed.

Numerous studies have investigated behavioral momentum and its utility in establishing or occasioning new and low-probability responses. Behavioral momentum strategies have been linked to positive outcomes across a range of socially significant domains related to both performance behavior, such as compliance with social requests (Davis, Brady, Hamilton, McEvoy, & Williams, 1994), and decreasing aberrant behavior (Mace & Belfiore, 1990), and learning behavior, including vocabulary growth (Kelly & Holloway, 2015) and the establishment of the first instances of vocal, verbal behavior (Ross & Greer, 2003; Tsiouri & Greer, 2003, 2007).
Performance. As defined by Greer and Ross (2008), performance behaviors consist of “previously learned operant behaviors” that come to be associated with specific events in the environment, or the behaviors of other individuals in the environment. To date, the bulk of the educational research related to behavioral momentum involves these performance behaviors, with a significant number of studies related to improving compliance and on-task behavior for students in the classroom.

Several applied researchers have demonstrated that high-probability sequences grounded in behavioral momentum have improved noncompliant academic behaviors for students with behavioral difficulties. Belfiore, Lee, Vargas, and Skinner (1997) first tested the effects of a high-probability antecedent intervention in academics. After conducting preference assessments of math activities for two students who had academic compliance difficulties, they presented two to three one-digit addition problems (high-p) before each three-digit by three-digit multiplication problem (low-p) was presented. Results demonstrated that the students completed the multiplication problems faster when the high-p procedure was in place. Similarly, Banda and Kubina (2010) investigated the effects of a high-probability task sequence on the completion of low-probability mathematics problems by a student with autism and found that the student completed the low-p problems at a faster rate when they were preceded by high-p math problems.

The use of high-probability sequences has been useful in increasing social interactions and communication for children with social delays, as well. Often, the high-p request procedure was combined with other intervention strategies, including strategies to promote generalization (Davis, Brady, Hamilton, McEvoy, & Williams, 1994), peer mediation (Davis & Reichle, 1996), and peer modeling (Jung, Sainato, & Davis, 2008). However, because the high-p task sequence is
frequently used in conjunction with other interventions, it is difficult to isolate the variables responsible for the reported effects across these studies. Moreover, much of the research fails to report occurrences of unprompted social behavior after the high-p intervention is removed.

**Learning.** Behavioral momentum as it pertains to learning novel behaviors has received considerably less attention than behavioral momentum and performance behaviors. Studies that do investigate the role of behavioral momentum in the acquisition of novel behavior are primarily focused on the development of verbal behavior.

Kelly and Holloway (2014) evaluated the effectiveness of behavioral momentum in the acquisition of tacts and associated measures of fluency. During intervention, the experimenters presented a series of 20 mastered stimuli which the participants were required to tact as quickly as possible; following this high-p request sequence, the experimenters presented a set of unknown stimuli for 1 min and recorded correct and incorrect tacts emitted by the participants. After the timing, the experimenter delivered corrective feedback for the stimuli tacted during the session. Results demonstrated that the participants not only acquired the tacts with the behavioral momentum procedure in place, as compared to baseline, but that they maintained the tacts over time, as well.

Ross and Greer (2003) used a behavioral momentum strategy, rapid motor imitation, to establish echoic and independent mands and tacts in preschoolers who demonstrated no vocal verbal behavior at the onset of the study. The rapid motor imitation antecedent involved the presentation of large and small motor actions, which the participants were required to imitate, prior to the delivery of the echoic target. Results demonstrated that the rapid motor imitation antecedent was effective in inducing echoics, mands, and tacts for all the participants; that is, Ross and Greer (2003) found that the procedure was effective in inducing the first instances of
speech for children who did not demonstrate an echoic repertoire prior to the intervention. These findings were replicated in subsequent experiments and extended to tacts (Tsiouri & Greer, 2003, 2007).

Behavioral momentum has also been tied to positive outcomes in learning complex verbal stimuli, such as those involved in learning to read. Vostal and Lee (2011) used a behavioral momentum strategy during a continuous reading task assigned to adolescents identified with emotional and behavioral disorders; they found that when the participants were presented with a third-grade level reading passage prior to the presentation of a fifth-grade level passage, the participants initiated reading the fifth-grade level passages more quickly and read an increased number of words correctly per min. Burns, Ardoin, Parker, Hodgson, Klingbeil, and Scholin (2009) compared behavioral momentum with an interspersal technique on the number of words fourth-grade students read correctly when reading word lists. During the behavioral momentum condition, a series of easier words was placed at the beginning of the word lists, whereas during the interspersal condition, easier words were interspersed throughout the word lists. Burns et al. (2009) found that the participants read significantly more words correctly per min when behavioral momentum was used; that is behavioral momentum increased accuracy as well as fluency.

**Synthesis of Current Research**

Learning to read can be an arduous task, as evidenced by research from both educational and behavioral domains. Despite the wide range of instructional approaches available, there remain a significant number of school-aged children at risk for reading failure. Less research has been devoted to the significance of blending and segmenting speech sounds when an individual
first learns to respond to text, a gap that could account for one of the major challenges low-performing readers encounter.

From a behavioral perspective, Lyons’ (2014) study came the closest to examining the relationship between blending and segmenting and the establishment of a textual responding repertoire. Lyons (2014) showed that when students learned to match component sounds to composite words, they subsequently learned to blend component sounds to textually respond to novel words, as well. Lyons suggested that blending to read words involved speaker-as-own-listener behaviors; individuals need to listen to their production of individual speech sounds, either overtly or covertly, to textually respond to words, particularly when first learning to read. However, Lyons’ participants were only required to function as listeners during her intervention; that is, they matched the component sounds and composite words that an audio recording produced. This suggested that the repertoire to switch from component-to-composite and vice versa as a listener was a necessary, if not sufficient, variable to establish blending, but did not account for speaker-as-own-listener responding as a component of reading instruction. Currently, there are no studies related to the role of speaker-as-own-listener responding as a component of explicit blending and segmenting instruction and how this might impact the establishment of textual behavior.

**Rationale**

The purpose of the present study is to investigate the effects of a behavioral momentum blending intervention on the accuracy of textual and spelling responses emitted by preschool students who demonstrate similar blending difficulties to the participants in Lyons’ (2014) study. Behavioral momentum has been used as an effective tactic in moderating performance behaviors, and, to a lesser extent, learning new behaviors. In addition to the behavioral momentum tactic,
the intervention in this study requires speaker-as-own-listener responding, which further differentiates it from Lyons’ auditory matching intervention. The body of research related to the development of verbal behavior suggests that speaker-as-own-listener responding is critical in the acquisition of higher-order cusps and repertoires, including those related to reading.

**Research Questions**

The research questions addressed in this study included: 1) Does a behavioral momentum blending intervention affect the number of correct textual responses to words comprised of previously mastered phoneme-grapheme correspondences? 2) Does the behavioral momentum blending intervention affect speaker-as-own-listener behaviors; that is, do students emit correct textual responses only after emitting the corresponding component phonemes overtly, or do they emit correct composite textual responses following an intervention in which they must respond as listeners to their own speaker behaviors? 3) Does the behavioral momentum blending intervention increase vocally blended responses? 4) Does the behavioral momentum blending intervention affect the number of correctly spelled words comprised of previously mastered phoneme-grapheme correspondences?
Table 1

Reading Terms and Definitions

<table>
<thead>
<tr>
<th>Term</th>
<th>Definition</th>
<th>Example</th>
</tr>
</thead>
<tbody>
<tr>
<td>Phonological Awareness</td>
<td>“The ability to hear and remember a variety of units of sounds within words: syllable, syllable fragment (onsets/rimes), phoneme” (McGuinness, 2005, p. 440).</td>
<td>Children with phonological awareness can manipulate units of oral language. They can identify and make oral rhymes, clap out syllables in words, and identify words with the same initial sounds.</td>
</tr>
<tr>
<td>Phonemic Awareness</td>
<td>The ability to recognize that words are made up of phonemes (Paul &amp; Wang, 2012)</td>
<td>Children with phonemic awareness can hear, identify and manipulate the individual sounds in words. A child with phonemic awareness can separate the spoken word “cat” into three distinct phonemes: /c/, /a/, /t/.</td>
</tr>
<tr>
<td>Phonics</td>
<td>“A generic term for any reading method that teaches a relationship between letters and phonemes” (McGuinness, 2005, p. 44).</td>
<td>Phonics-related activities focus on letter-sound relationships and include letter naming, identifying digraphs and trigraphs, and reading regular words, or words in which each letter in the word corresponds to its most common sound.</td>
</tr>
<tr>
<td>Phoneme</td>
<td>The smallest unit of speech that a person can hear; phonemes can correspond to consonants, vowels, or combinations of both (McGuinness, 2005)</td>
<td>In the spoken word “cat,” /c/, /a/, and /t/ are all individual phonemes.</td>
</tr>
<tr>
<td>Term</td>
<td>Definition</td>
<td>Example</td>
</tr>
<tr>
<td>-------------------------------</td>
<td>----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------</td>
<td>--------------------------------------------------------------------------</td>
</tr>
<tr>
<td><strong>Grapheme</strong></td>
<td>Written representations of phonemes that can include one or multiple letters (Kandel &amp; Spinelli, 2010)</td>
<td>In the written word “cat,” the symbols c, a, and t are all individual graphemes.</td>
</tr>
<tr>
<td><strong>Phoneme-Grapheme Correspondence</strong></td>
<td>Matching phonemes (sounds) to graphemes (symbols); the building blocks of the orthographic code (Moats, 2010)</td>
<td>In the word “cat,” the written symbols c, a, and t relate to specific individual sounds: /c/, /a/, /t/.</td>
</tr>
<tr>
<td><strong>Blending</strong></td>
<td>The process of joining a sequence of isolated phonemes to form a word; the process can be performed with or without text (McGuinness, 2004).</td>
<td>When presented with the segmented sounds /c/, /a/, /t/, the correct blend is the word “cat.”</td>
</tr>
<tr>
<td><strong>Segmenting</strong></td>
<td>The process of separating individual phonemes in sequence within a word; the process can be performed with or without text (McGuinness, 2004).</td>
<td>When presented with the word “cat,” the segmented sounds are /c/, /a/, /t/.</td>
</tr>
<tr>
<td><strong>Textual Responding</strong></td>
<td>A verbal operant under the control of printed verbal stimuli (Skinner, 1957); with a textual response, there is point-to-point correspondence between the stimulus and the response, but no formal similarity; synonymous with decoding from an educational perspective</td>
<td>The student sees the printed word “cat,” and says, “cat” out loud. Textual behavior can also occur at the covert level, or within the skin; it may not always be vocal.</td>
</tr>
<tr>
<td><strong>Speaker-as-own-listener</strong></td>
<td>The rotation between the speaker and listener within the skin. When learning to read words phonetically, an individual must listen to his or her own production of the component sounds in the word and then blend those sounds.</td>
<td>A child who emits self-talk during toy play, such as when mimicking a conversation between two or more toys, demonstrates speaker-as-own-listener responding. The child must listen to his or her own production of the words and then blend those sounds.</td>
</tr>
</tbody>
</table>
Chapter II

EXPERIMENT 1

Method

Participants

Five male students, between the ages three and four years, participated in the study. The students attended a Comprehensive Application of Behavior Analysis to Schooling (CABAS®) model school that applied a behavior-analytic approach to all pedagogical practices. The participants were identified as preschoolers with disabilities and were selected from the same self-contained classroom. They were accustomed to receiving positive reinforcement operations for correct responses during academic instruction as well as for demonstrating rule-following behavior throughout the school day. Reinforcement was delivered in the form of praise and tokens, which were exchanged for back-up reinforcers throughout the day, including preferred leisure activities, edibles, and toys.

The experimenter determined the participants’ existing verbal behavior cusps, new learning capabilities, and repertoires using CABAS®-specific assessments. Table 2 includes a full description of these repertoires. The results of these assessments indicated that the participants demonstrated fluent basic and advanced listener literacy, basic speaker functions, could match printed words, and could textually respond to all letter sounds, or graphemes that corresponded to the 44 phonemes in the English language. In addition, the participants demonstrated say-do correspondence, generalized imitation, and generalized matching with two-dimensional and three-dimensional stimuli. All the participants demonstrated bi-directional Naming (BiN) and Participant S had the observational learning capability; that is, he learned
from being exposed to the consequences other students received. The participants were selected because they emitted low numbers of correct responses to words comprised of previously mastered phoneme-grapheme relations. In other words, the participants textually responded to individual letter sounds in regular words comprised of, at most, five different sounds, but did not blend the sounds together to textually respond to whole words. The participants had received initial reading instruction using the Direct Instruction curriculum, “Teach Your Child to Read in 100 Easy Lessons,” (Englemann, Haddox, & Bruner, 1986) but demonstrated limited to no progress blending to textually respond.

Setting and Materials

All probe and intervention sessions occurred in the participants’ self-contained classroom. The classroom included six child-sized tables used for instruction, a Smartboard®, and plastic child-sized chairs. During all probe and intervention sessions, the participant sat facing the experimenter at one of the child-sized tables. There were up to 12 students and four adults in the classroom at any given time; while the sessions were occurring, the other adults and students in the classroom were engaged in daily instructional activities. This arrangement was standard practice in the classroom.

During the pre- and post-intervention probe sessions, the experimenter presented the words comprised of mastered phonemes using a PowerPoint® presentation on a laptop computer. Each word was presented on an individual slide using black Comic Sans font, size 236. For the spelling responses, the experimenter provided the participants with letter tiles representing the target phonemes in the words. Ten tiles depicting the following phonemes were used: /m/, /a/, /s/, /t/, /e/, /r/, /i/, /d/, /c/, and /th/. Tiles were used because the participants had not learned to write. The experimenter used the following materials to collect and record data
Table 2

Participants’ Verbal Cusps, Capabilities, and Relevant Academic Repertoires for Experiment 1

<table>
<thead>
<tr>
<th>Participant</th>
<th>Age</th>
<th>Gender</th>
<th>Diagnosis</th>
<th>Relevant Cusps, Capabilities and repertoires</th>
<th>Standardized Test Scores</th>
</tr>
</thead>
<tbody>
<tr>
<td>S</td>
<td>3</td>
<td>Male</td>
<td>Preschooler with a disability</td>
<td>Conditioned reinforcement for faces; conditioned reinforcement for voices; conditioned reinforcement for 3D objects/visual stimuli on desktop and 2D print stimuli; generalized motor imitation; conditioned reinforcement for observing book stimuli; listener literacy; Bi-directional Naming; observational learning; phoneme-grapheme correspondence</td>
<td>Batelle Developmental Inventory II - Adaptive 93 - Cognitive 98 - Communication 90 - Personal-Social 84</td>
</tr>
<tr>
<td>D</td>
<td>4</td>
<td>Male</td>
<td>Preschooler with a disability</td>
<td>Conditioned reinforcement for faces; conditioned reinforcement for voices; conditioned reinforcement for 3D objects/visual stimuli on desktop and 2D print stimuli; generalized motor imitation; conditioned reinforcement for</td>
<td>Batelle Developmental Inventory II - Adaptive 67 - Cognitive 75 - Communication 78 - Motor 80 - Personal-Social 79</td>
</tr>
</tbody>
</table>

Weschler Preschool & Primary Scales of Intelligence IV - Full Scale IQ 77 (Composite)
observing book stimuli; listener literacy; Bi-directional Naming; phoneme-grapheme correspondence

-Visual Spatial Index 78 (Composite)
-Verbal Comprehension Index 82 (Composite)
-Working Memory Index 87 (Composite)

Preschool Language Scale-5
-Auditory Comprehension 98
-Expressive Communication 75
-Total Language 85

| J  | 4  | Male | Preschooler with a disability | Conditioned reinforcement for faces; conditioned reinforcement for voices; conditioned reinforcement for 3D objects/visual stimuli on desktop and 2D print stimuli; generalized motor imitation; conditioned reinforcement for observing book stimuli; listener literacy; Bi-directional Naming; observational learning; phoneme-grapheme correspondence | Battele Development Inventory II
-Adaptive 87
-Cognitive 81
-Motor 87
-Personal-Social 83

Preschool Language Scale 5
-Auditory Comprehension 98
-Expressive Language 77

| Z  | 4  | Male | Preschooler with a disability | Conditioned reinforcement for faces; conditioned reinforcement for voices; conditioned reinforcement for 3D objects/visual stimuli on desktop and 2D print stimuli; conditioned reinforcement for observing book stimuli; listener literacy; Bi-directional Naming; observational learning; phoneme-grapheme correspondence | Development Assessment of Young Children
-Adaptive Behavior Development 84
-Cognitive 81
-Expressive Language 60
-Fine Motor 83 |
Note. The cusps and capabilities listed above are derived from Verbal Behavior Development theory, which suggests that an individual’s behavioral development is directly linked to the acquisition of conditioned social reinforcers; in this case, reader behavior emerges following the acquisition of the relevant cusps listed herein. The Preschool Language Scale-5 is an interactive assessment of developmental language skills that involves pointing and vocally responding to pictures and objects. The Batelle Developmental Inventory II is a developmental assessment for young children that screens and evaluates early childhood developmental milestones. The Weschler Preschool & Primary Scales of Intelligence IV is an intelligence test for children ages 2 to 7 that measures cognitive development. The Developmental Assessment of Young Children is a test used to identify children from birth through age 5 with possible developmental delays related to cognition, communication, social-emotional development, physical development, and adaptive behavior. All scores are reported as standard scores.
during the probe sessions: 1) A data form containing 60 regular words and pseudo-words comprised of two to five phonemes, represented by their corresponding graphemes, and derived from the list used in Lyons’ (2014) study (see Table 3; 2) An additional list containing 20 words selected from the list of 60, used for vocal blending probes (see Table 4); 3) A third list containing the first 20 words from the 60 word list, used to record spelling responses (see Table 3); 4) Additional data collection materials to record and graph, such as pens and graphs. For the spelling responses, the experimenter provided the participants with letter tiles representing the target phonemes in the words.

During intervention sessions, the experimenter presented the target words on 4”x 6” index cards with 20 cards included in each set. The words were handwritten using black marker. In addition, during fluency phases, the experimenter used a timer to determine the duration of responding to calculate rate. Data collection materials used during the intervention sessions included data collection sheets, pens, and graphs used to analyze progress throughout the phases.

**Dependent Variables**

**Blending responses to novel text stimuli.** The first dependent variable was the participants’ textual responses to regular words and regular pseudo-words comprised of mastered phoneme-grapheme correspondences. A regular word was defined as a word in which each grapheme corresponded to only one phonemic sound. A pseudo-word, in turn, consisted of a string of letters that conformed to English orthographic patterns to which the participants could phonetically textually respond; however, the words had no meaning. The words were derived from Lyons’ (2014) study. As in Lyons’ study, the experimenter recorded component as well as composite responses; that is, the experimenter recorded instances in which the participant emitted each component phoneme as it corresponded to the printed grapheme, followed by the
correct composite textual response, as well as instances in which the participant emitted the composite textual responses without overtly responding to the phonemes. During the sessions, the experimenter and the participant sat at a child-sized table facing each other, with a laptop computer situated to the experimenter’s right and displaying the target words on PowerPoint® slides. The experimenter provided two model responses at the beginning of each probe session, which involved textually responding to each of the letter sounds in the model word followed by modeling the correct composite response. For each target word that followed, the experimenter pointed to the word and instructed the participant to, “Read the word.” A correct response consisted of the participant textually responding to the target word within 5 s; additionally, correct responses included instances in which the participant emitted each component phoneme represented by a grapheme followed by the correct composite textual response. Incorrect responses included responses in which the participant emitted the incorrect composite textual response, the correct component phonemes followed by the incorrect composite response, the incorrect component phonemes and incorrect composite response, as well as failure to respond within 5 s. The experimenter did not provide consequences for correct or incorrect responding. Correct responses were represented with a plus (+) on the data collection sheet and incorrect responses were represented by a minus (-).

For Participants J, Z, and A, an additional series of probe sessions were conducted using 60 novel words and pseudo-words (Table 5). Two probe sessions were conducted for each participant using the novel word set. The first session using novel words was conducted exactly as the probe sessions using the original word set were conducted. During the second probe session with novel words, the experimenter provided two models of composite only textual responding prior to directing the participant to begin reading.
**Vocal blending responses.** The second dependent variable was the number of correct composite blending responses the participants emitted after listening to the experimenter say each of the component phonemes that comprised the target word; no visual stimuli were used during this probe. For example, if the experimenter said, “/s/-/a/-/d/,” the correct response was, “sad.” All the words used in the probes were selected from the list of 60 words and pseudo-words. Each session consisted of 20 unconsequated probe trials and began with the experimenter providing two models of vocal blending. Correct responses were denoted by a plus (+) and incorrect responses were denoted by a minus (-). For the final probe session, Participants J, Z, and A were required to vocally blend 20 novel words, or words not used in the previous probe sessions (see Table 6).

**Dictated spelling responses to words comprised of mastered phonemes.** The third dependent variable consisted of the number of correctly selected and sequenced graphemes into words that were comprised of mastered phoneme-grapheme correspondences; the words used were the first 20 words to which the participant was asked to textually respond for the first dependent measure. During the probe, the experimenter provided the participants with ten tiles on which the target phonemes were printed. The experimenter provided the vocal antecedent, “Spell __________” and the participant was allowed 10 s to respond. Responses were not consequated. The experimenter recorded the number of correctly selected phonemes as well as the number of words the participant spelled correctly by sequencing the letter tiles in the correct order. As with the previous two dependent measures, Participants J, Z, and A were required to spell novel words during their final series of probe sessions (see Table 5).
Table 3

60 Words and Pseudo-words comprised of Previously Mastered Phoneme-Grapheme Correspondences

<p>| | | |</p>
<table>
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<td>tac</td>
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<td>mac</td>
<td>rac</td>
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<tr>
<td>mist</td>
<td>cast</td>
<td>tast</td>
</tr>
<tr>
<td>sis</td>
<td>diss</td>
<td>rist</td>
</tr>
<tr>
<td>thad</td>
<td>thim</td>
<td>meet</td>
</tr>
<tr>
<td>seet</td>
<td>reem</td>
<td>deem</td>
</tr>
<tr>
<td>mith</td>
<td>rath</td>
<td>this</td>
</tr>
<tr>
<td>seer</td>
<td>deed</td>
<td>smit</td>
</tr>
<tr>
<td>stam</td>
<td>trad</td>
<td>stad</td>
</tr>
<tr>
<td>tham</td>
<td>thist</td>
<td>cath</td>
</tr>
<tr>
<td>stic</td>
<td>rim</td>
<td>street</td>
</tr>
<tr>
<td>tree</td>
<td>teeth</td>
<td>sreeth</td>
</tr>
</tbody>
</table>

Words in bold were also words participants were asked to spell with letter tiles for dependent variable 3.
Table 4

*Dependent Variable 2: Words used during Vocal Blending Probes.*

<table>
<thead>
<tr>
<th>Tat</th>
<th>Sam</th>
<th>Sis</th>
<th>Sad</th>
<th>Rit</th>
<th>Mic</th>
<th>Sac</th>
<th>Tast</th>
<th>Mas</th>
<th>Thin</th>
<th>Mith</th>
<th>Reem</th>
<th>Deed</th>
<th>Smit</th>
<th>Stam</th>
<th>Street</th>
<th>Tree</th>
<th>Stic</th>
<th>Deem</th>
<th>Meet</th>
</tr>
</thead>
</table>
Table 5

60 words and pseudo-words used for novel set textual responding probes

<table>
<thead>
<tr>
<th>drop</th>
<th>keep</th>
<th>steep</th>
</tr>
</thead>
<tbody>
<tr>
<td>flip</td>
<td>molt</td>
<td>deep</td>
</tr>
<tr>
<td>sand</td>
<td>leet</td>
<td>weet</td>
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<tr>
<td>cog</td>
<td>peel</td>
<td>weel</td>
</tr>
<tr>
<td>dust</td>
<td>teel</td>
<td>bath</td>
</tr>
<tr>
<td>spot</td>
<td>pric</td>
<td>tweed</td>
</tr>
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<td>bump</td>
<td>brad</td>
<td>peer</td>
</tr>
<tr>
<td>hot</td>
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<td>reep</td>
</tr>
<tr>
<td>slid</td>
<td>rut</td>
<td>sag</td>
</tr>
<tr>
<td>gum</td>
<td>mot</td>
<td>plum</td>
</tr>
<tr>
<td>hunt</td>
<td>pill</td>
<td>mull</td>
</tr>
<tr>
<td>sweet</td>
<td>tan</td>
<td>gall</td>
</tr>
<tr>
<td>rip</td>
<td>past</td>
<td>mir</td>
</tr>
<tr>
<td>peep</td>
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<td>hath</td>
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<td>reef</td>
<td>glee</td>
<td>lat</td>
</tr>
<tr>
<td>twin</td>
<td>beed</td>
<td>tilt</td>
</tr>
</tbody>
</table>

Note. Words in bold were used for spelling probes
Table 6

*20 words used during novel set post-intervention vocal blending probes.*

<table>
<thead>
<tr>
<th>cog</th>
<th>bump</th>
<th>Gum</th>
<th>Sweet</th>
<th>Tin</th>
<th>Reef</th>
<th>Pric</th>
<th>Rut</th>
<th>Pill</th>
<th>Past</th>
<th>Fast</th>
<th>Beed</th>
<th>Streep</th>
<th>Tweed</th>
<th>Sag</th>
<th>Plum</th>
<th>Mut</th>
<th>Hath</th>
<th>Reet</th>
<th>Lat</th>
</tr>
</thead>
</table>
Data Collection

During the probe sessions, the experimenters collected data on the number of correct textual responses, vocal blending responses, and spelling responses the participants emitted using a total count. After each session, the number of correct responses was totaled and graphed as a total number correct out of the possible total probe trials across sessions using an Excel spreadsheet. In addition, for the tests of textual responding to the 60 words and pseudo-words, the experimenters totaled the count for component-followed-by-composite responding as well as composite-only responding. These totals made it possible to compare responding within and across sessions as the intervention progressed.

Similarly, during the intervention sessions, the experimenters recorded the number of correct textual responses the participants emitted to each word set. These data were totaled at the end of each session and graphed as a number correct out of 20. The participants’ responses to the behavioral momentum blending antecedent were not recorded or graphed.

Independent Variable

The independent variable consisted of a behavioral momentum blending intervention (BMBI) to teach the participants to textually respond to regular words. Figure 1 provides a flow chart illustrating the sequence of instruction implemented during each intervention session, including procedural additions during Experiment 2, which will be described in Chapter III. During implementation of the pre-training phase and subsequent phases of the intervention, the participants’ phonics-related reading programs were suspended until completion of the experiment.
The intervention consisted of an instructional sequence that was responsive to patterns in student responding. The steps in the sequence included:

1) The use of a behavioral momentum blending antecedent followed by the instructor vocally segmenting the component phonemes in a novel printed word and requiring the participant to read the composite word;

2) The instructor vocally segmenting the component phonemes in the printed word followed by the participant reading the composite word, with no behavioral momentum antecedent;

3) The instructor directing the participant to vocally segment the component phonemes in the printed word, then read the composite word. Composite only responding with no segmentation was also considered correct.

Procedures implemented at each step are described in more detail in subsequent sections.
<table>
<thead>
<tr>
<th>Table 7</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Words/pseudo-words in each set of the behavioral momentum blending procedure.</strong></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Set 1</th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>did</td>
<td>mad</td>
<td>Dad</td>
<td>mast</td>
<td>that</td>
</tr>
<tr>
<td>stat</td>
<td>ram*</td>
<td>seem</td>
<td>reed</td>
<td>rid</td>
</tr>
<tr>
<td>meer</td>
<td>deer</td>
<td>miss</td>
<td>trim</td>
<td>stim</td>
</tr>
<tr>
<td>mit</td>
<td>sit</td>
<td>math</td>
<td>see*</td>
<td>steed</td>
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<td>creep</td>
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<td>drum</td>
<td>grunt</td>
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<td>Set 6</td>
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<tr>
<td>thing</td>
<td>breed</td>
<td>Trunk</td>
<td>skip</td>
<td>slid</td>
</tr>
</tbody>
</table>

Note. For Participant A, “see” in Set 1 was changed to the word “seep.”
Step One: Behavioral Momentum Blending Antecedent and Vocal Segmentation Model
- Experimenter rapidly presents five training words under same conditions as prerequisite training, followed by a novel word. Experimenter vocally segments component phonemes in novel word, and participant is required to emit composite textual response.

2 correct consecutive responses

Step Two: Vocal Segmentation Model Only
- Experimenter vocally segments phonemes in novel word, and participant is required to emit composite textual response. No Behavioral Momentum Blending Antecedent.

2 correct consecutive responses

Step Three: Learn Unit Instruction for Component-to-Composite Responding
- Experimenter presents novel word. Participant is required to vocally segment component phonemes then emit composite textual response. Composite only textual responses were also considered correct.

2 correct consecutive responses

Step Four: Learn Unit Instruction for Composite Responding Only
- Experimenter presents novel word. Participant is required to emit the composite response (i.e. “Read the whole word.”) Component-to-composite responding was considered incorrect under this condition.

2 incorrect consecutive responses

Figure 1. Figure 1 shows a flowchart of the sequence of the Behavioral Momentum Blending Intervention implemented during each session. For every two consecutive correct responses, the response requirements for instruction changed, requiring the participants to gradually respond to their own speaker behavior while observing the text. For every two consecutive incorrect responses, the instruction shifted in the opposite sequence. Step Four, involving composite only responding, was implemented during Experiment 2 only.
Experimental Design

The experimenters used a multiple probe design across participants, with probe sessions conducted simultaneously at the beginning of the study for the first two participants as well as directly prior to implementation of the intervention for Participant D. Participants J, Z, and A completed their first series of pre-intervention probes at the same time as Participant D’s second set of post-intervention probes.

The sequence of the experiment occurred as follows: 1) The experimenter conducted pre-intervention probes across all three dependent measures for the first two participants simultaneously and independently; 2) The experimenter began the pre-training phases followed by the behavioral momentum blending intervention for Participant S; 3) After Participant S met the mastery criterion in Phase 2 of the intervention, the experimenter conducted post-intervention probes across the three dependent measures, and a second set of pre-intervention probes across the three measures for Participant D; the first series of pre-intervention probes for Participants J, Z, and A were also conducted at this time ; 4) Participant S continued the behavioral momentum blending intervention and the experimenter began the intervention for Participant D; 5) After Participant D demonstrated criterion-level responding in Phase 2 of the intervention, he completed post-intervention probes and Participant J completed a second series of pre-intervention probes; 6) Participant J began intervention and the experimenter continued to implement the behavioral momentum blending intervention with Participants S and D. The experiment continued in this sequence, with post-intervention probes following every two phases of intervention until the participants responded with 90% accuracy to the textual responding measure. Participant Z completed a second set of pre-intervention probes when Participant J
completed his first post-intervention probes, and Participant A completed his second series of pre-intervention probes at the same time as Participant Z’s post-probes.

**Experimental Procedures**

*Pre-intervention tests of the dependent variables.* Prior to the implementation of the behavioral momentum blending intervention, the experimenter conducted pre-intervention tests of the dependent variables across all three measures for the participants. The first series of pre-intervention probes was conducted simultaneously across the first two participants, after which time Participant S began the pre-training phase of the intervention. Participants D, J, Z, and A all completed two or more sets of pre-intervention probes until steady state responding was observed across all measures.

*Pre-experimental instruction for the behavioral momentum blending intervention (BMBI).* Prior to the implementation of the intervention, the participants completed pre-experimental instruction that required them to master textually responding to a set of known regular words at a specified rate. Known words were selected from early reader texts, such as the Reading A-Z series, and were words the participants had previously learned as a component of their daily reading instruction. During fluency training, the experimenter presented a word on a 4” x 6” index card, vocally segmented each of the component phonemes represented by the graphemes in the word and provided the participant with 3 s to textually respond to (blend) the word. Individual responses were not consequated during fluency training; rather, the experimenter separated correct responses and incorrect responses into two piles during each session and provided consequences when the participant had finished responding to the entire set. For incorrect responses, the experimenter delivered a correction procedure, which consisted of re-presenting the errored words, delivering the segmented antecedent of the component
phonemes, providing a model of the correct response, and requiring the participant to emit the correct response independently. Responses during the correction procedure were not reinforced, even if the participant emitted the correct response. In total, 10 pre-training words were included in a set, and sets varied between the participants depending on the regular words that were already in repertoire. The target rate criterion was 30 correct textual responses per min with 0 incorrect responses.

**Behavioral momentum blending intervention (BMBI).** When the participants emitted the composite textual responses to the pre-training words at the target rate, the experimenter implemented a behavioral momentum blending intervention (BMBI) that required the participants to textually respond to novel words. Each phase of the behavioral momentum blending intervention involved training a set of 20 words and pseudo-words to mastery, then to a fluency criterion. At the beginning of each session, the experimenter presented a behavioral momentum blending antecedent which involved the presentation of five pre-training words in rapid succession under the same conditions as the pre-training phase. Immediately following the presentation of the last word, the experimenter presented a novel word, vocally segmented the component phonemes that represented the graphemes in the word and provided the participant with 3 s to textually respond. For example, given the word, “sad,” the experimenter segmented the phonemes, /s/ /a/ /d/, and the participant was required to blend the composite word, sad. If the participant emitted the correct composite textual response, or blended accurately, the experimenter provided reinforcement in the form of praise and tokens and presented the behavioral momentum blending antecedent a second time using the five training words different than those presented in the previous antecedent. If the participant did not emit the composite textual responses, the experimenter provided a correction in which she segmented each of the
component phonemes in the word an additional time followed by a model of the correct composite response; then, provided the participant with the opportunity to textually respond to the word independently. Incorrect responses did not receive reinforcement. At this step, the participant was required to listen to another individual’s speaker behavior (the instructor) and then provide the composite response.

After two correct consecutive responses following the behavioral momentum blending antecedent and the experimenter’s segmented model of the component phonemes represented by the graphemes, the experimenter shifted to learn unit presentations (Albers & Greer, 1991) without the behavioral momentum blending antecedent. Vocally segmented models of the component phonemes representing the graphemes in each word continued to be provided; however, after two consecutive correct responses with the experimenter’s vocal model, the experimenter shifted to learn unit presentations without vocal models of the component phonemes. Under this condition, the experimenter provided learn unit instruction in which the participant was required to segment the individual phonemes in the word, then blend the sounds together to emit the composite word. At this step, the participant was required to function as a speaker-as-own-listener; that is, he or she needed to listen to his or her own vocal segmentation of the sounds, then blend those sounds together to read the whole word.

The experimenter shifted in the opposite sequence for incorrect responses. That is, after two incorrect responses with component-to-composite learn unit instruction, the experimenter shifted back to presentations with the vocal model, and after two incorrect responses with the vocal segmentation but without the behavioral momentum blending antecedent, the experimenter shifted back to a behavioral momentum blending antecedent. Criterion for each set of 20 words and pseudo-words was 90% accuracy of responding in two consecutive sessions or 100%
accuracy of responding in one session. Intervention sets were counterbalanced across Participants J, Z, and A, but not Participants S and D (see Table 8).

Following mastery of each set of words, the experimenter implemented a fluency condition that was identical to the fluency condition described for the pre-experimental words. Once the participants textually responded to the target words in the set at a rate of 30 correct textual responses per min and 0 incorrect responses, a new set of 20 novel target words and pseudo-words was introduced. Intervention continued until the participants textually responded to the words that comprised the first dependent variable with 90% accuracy or greater. Probe sessions were conducted following every two phases of intervention.

**Post-intervention tests of the dependent variables.** Post-intervention tests of the dependent variables were identical to the pre-intervention probes.
Counterbalanced sets of target words and non-words during Experiment 2 across participants.

<table>
<thead>
<tr>
<th>Participant</th>
<th>Phase 1</th>
<th>Phase 2</th>
<th>Phase 3</th>
<th>Phase 4</th>
<th>Phase 5</th>
<th>Phase 6</th>
<th>Phase 7</th>
<th>Phase 8</th>
<th>Phase 9</th>
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<tr>
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<td>4</td>
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<td>6</td>
<td>7</td>
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<td>3</td>
<td>5</td>
<td>8</td>
<td>7</td>
<td></td>
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</tr>
</tbody>
</table>
Interobserver Agreement

The experimenter calculated interobserver agreements (IOA) for the probe sessions to increase the accuracy and reliability of the data reported. In the sessions, IOA was calculated by dividing the number of point-by-point agreements by the total number of agreements and multiplying the resulting number by 100. Interobserver agreements were obtained using videotaped recordings of the sessions. An observer who was blind to the conditions and objectives of the study was calibrated to a predetermined standard and viewed the recordings to provide IOA.

Interobserver agreements were collected and calculated for 50% of Participant S’s probe sessions. The mean percentage of agreement for Participant S was 99% with a range of 97% to 100%. For Participant D, IOA was collected for 33% of all probe sessions and the mean percentage of agreement was 98.5% with a range between 97% and 100%. IOA was collected for 40% of Participant J’s probe sessions with 100% agreement each time it was conducted. For Participant Z, IOA was collected for 80% of the probe sessions with a range of 95% to 100% agreement. The mean percentage of agreement was 99.75%. The experimenters collected IOA for 74% of Participant A’s probe sessions with 100% agreement across all sessions.

Results

The first research question addressed in this study considered if the BMBI procedure would affect the number of correct textual responses the participants emitted to novel, regular words. Figure 2 represents the number of correct component-to-composite responses as well as the number of correct composite only responses for all participants. During the first series of pre-intervention probes, Participant S emitted 3 correct textual responses, Participant D emitted 6
correct responses, Participant J emitted 15 correct responses, Participant Z emitted no correct responses, and Participant A emitted 1 correct response. Participant S completed only one pre-intervention probe and Participant D emitted 7 correct responses in his second pre-intervention probe session. Following one to two additional probe sessions for the remaining participants, steady state responding was observed. During the first post-intervention probe sessions, increases in the number of correct textual responses were observed for all participants, to varying degrees. Participants S, D, J, Z, and A emitted 23, 44, 43, 9, and 24 correct responses, respectively, and except for Participant D, all the participants emitted more component-to-composite than composite only responses. In the second series of post-intervention probe sessions, additional increases were observed across all participants and Participants D and J textually responded to the words with at criterion-level, with 57 and 56 correct responses, in that respective order. Participant S emitted 40 correct responses, Participant Z emitted 24 correct responses, and Participant A emitted 38 correct responses. Participant S textually responded to the words with 90% accuracy during the third post-intervention probe, emitting 55 correct responses. Participant A achieved this criterion in the fourth probe session, emitting 56 correct responses. Participant Z responded at criterion-level during the fifth post-BMBI probe.

Additionally, the second research question aimed to examine the relationship between speaker-as-own-listener behavior and the behavioral momentum blending intervention; specifically, the question asked if participants would overtly emit the component phonemes in the word prior to blending the composite word following the intervention. Figure 2 also highlights the differences in component-to-composite and composite only textual responding before and after intervention. Participants S, J, Z, and A all emitted more component-followed-by-composite responses than composite only responses throughout the post-intervention probe
sessions, including the first probe session conducted with novel words for Participants J, Z, and A; however, when composite only responding was modeled using the novel words in the final probe, the final three participants emitted more composite only responses than they had in any of the other post-intervention sessions. Composite only responding was not modeled for Participants S or D.

The third research question raised was: Does the behavioral momentum blending intervention increase vocally blended responses? Figure 3 depicts the number of correct vocal blending responses without textual stimuli. Participant S emitted 0 correct vocal blending responses during his first pre-intervention session, Participant D emitted 3 correct responses, Participant J emitted 11 correct responses, Participant Z emitted one blend, and Participant A emitted 2 correct blends. In the second pre-BMBI session, Participants D and A emitted the same number of correct responses, while Participant J emitted 10 correct responses and Participant Z emitted no correct responses. Only one pre-intervention probe session was conducted for Participant S. Following the first two phases of intervention, the number of correct vocal blends without text increased for all participants; Participants D, J, and A responded with 18 or more correct responses, while Participant S emitted 14 correct blends and Participant Z emitted 12 correct blends. In the second post-intervention probe session, Participant S vocally blended 15 words correctly and Participant Z vocally blended 18 words correctly. During his third post-intervention probe session, Participant S correctly blended all the 20 target words. Once the participants achieved criterion-level responding, or 18/20 correct responses, the number of correct vocal blends remained high and stable, including when novel sets of words were used during the final series of probes for Participants J, Z, and A.
The fourth research question considered the effects of the intervention on spelling responses. Figure 4 shows the number of correct dictated spelling responses. During the first pre-intervention probe session, Participants S and D both emitted 1 correct spelling response, Participant J emitted 2 correct spelling responses. In the second pre-intervention probe, Participants D and J emitted 5 and 4 correct responses, respectively; in his third pre-intervention probe, Participant J emitted 3 correct spelling responses. Participants Z and A did not emit any correct responses during either of their pre-intervention probe sessions. Following the first two phases of intervention, the number of correct spelling responses increased for all participants except Participant Z, who did not emit any correct responses. During this first probe session, Participant S emitted 3 correct responses, Participant D emitted 14 correct composite responses, Participant J emitted 10 correct responses, and Participant A emitted 5 correct responses. In the second post-BMBI probe session, the number of correct responses increased for all participants including Participant Z, who emitted 1 correct response. Participant D spelled all 20 words correctly during this session, and Participants S, J, and A emitted 9, 17, and 13 correct spelling responses in that respective order. Participants S, Z, and A all completed additional post-intervention probes for the spelling measure. During the third post-BMBI probe session, Participant S emitted 18 correct responses, Participant Z emitted 3 correct responses, and Participant A emitted 15 correct responses. In his final two probe sessions with the original set of words, Participant Z emitted 14, then 17, correct spelling responses. Participant A emitted 17 correct responses during his final probe with the original set. The number of correct spelling responses remained high and stable for Participants J, Z, and A when novel word sets were used during the final probe sessions. The number of component-to-composite and composite only responses varied across participants. Participant D emitted composite only responses across all
his probe sessions, and Participants S and J emitted more composite only responses as the probe sessions progressed. Participants Z and A continued to emit component-to-composite responses during all probes.

Figures 5 and 6 represent intervention data for all participants during sessions in which word sets were trained to mastery as well as fluency sessions. The participants required a widely varying number of sessions to demonstrate mastery across intervention phases.
Figure 2. Figure 2 shows the number of correct textual responses the participants emitted with component phonemes and the number of correct composite textual responses to words and pseudo-words comprised of previously mastered phoneme-grapheme correspondences during pre- and post-intervention probe sessions in Experiment 1.
Figure 3. Figure 3 shows the number of correct vocally blended words the participants emitted without textual stimuli during pre- and post-intervention probe sessions in Experiment 1.
Figure 4. Figure 4 represents the number of correct spelling responses to words and pseudo-words comprised of previously mastered phoneme-grapheme correspondences during pre- and post-intervention probe sessions in Experiment 1.
Figure 5. This figure shows the number of correct responses the participants emitted during Behavioral Momentum Blending Intervention (BMBI) sessions to teach the word sets to mastery.
Figure 6. This figure shows the rate of correct and incorrect textual responses emitted by the participants during the fluency phases of intervention.
Discussion

Results suggest that a functional relation exists between the behavioral momentum blending intervention and the number of accurate textual, vocally blended, and spelling responses the participants emitted. That is, following at least two phases of intervention, increases in the number of correct textual, spelling, and vocally blended responses occurred for all participants, who emitted few to no correct responses across all these same dependent measures during pre-intervention probes. Correct textual responses increased by roughly 20 words following the first two phases of intervention for Participants S, J, and A, as well, and more than 40 words for Participant D. Less significant effects were initially observed for Participant Z; during the first post-BMBI probe session, he read only 9 words correctly. However, as the intervention continued, results from subsequent post-intervention probes suggested a more pronounced effect, and, following ten phases of intervention, he responded to the words with over 90% accuracy.

These findings align with Lyons’ (2014) initial findings related to blending and the potential differences in levels of the joining of speaker and listener. For nearly all post-intervention probe sessions, Participants S, J, Z, and A responded correctly only after they overtly emitted the component phonemes in the words, whereas Participant D required fewer intervention sessions and textually responded without emitting the phonemes. This phenomenon was observed for spelling responding, as well; Participants S, J, Z, and A emitted the component phonemes in at least some, if not all, of the words prior to identifying the composite spelling response, and Participant D emitted composite responses only. These speaker-as-own-listener repertoires suggest that covert and overt reading behaviors may emerge hierarchically, or that the overt behaviors may function as a prerequisite for the covert behaviors that emerge later.
Across the five participants, other patterns in responding were evident. For example, for all the participants, vocally blended responses increased immediately and substantially following the implementation of the intervention; Participants D, J, and A vocally blended nearly all the words that comprise the measure during their first post-intervention sessions, and Participants S and Z vocally blended over half of the 20 words. Further, correct textual and vocal blending responses emerged prior to correct spelling responses. These initial findings may be explained by the structure of the intervention, which required the participants to blend, or join, phonemes to respond to a composite word, rather than segment sounds prior to joining those sounds to form a word, a repertoire required when learning to spell. It may be that spelling words requires a higher level of speaker-as-own-listener responding, in which both blending and segmenting sounds is necessary for accurate responding, as compared to textual responding, in which blending phonemes only may suffice. In general, this sequence of effects suggests a sequence for acquiring the blending abstraction and textually responding to regular words in which each grapheme corresponds to a phoneme that makes only one sound; moreover, the effects emphasize the significance of joint stimulus control across listener and speaker responses in learning to read.

The participants’ responding during the final post-BMBI probe of textual responding, in which composite responding was modeled at the beginning of the probe session, suggests that there were potential limitations to both the intervention sequence and the structure of the probe sessions. Specifically, composite responding may have occurred with significantly less frequency during the probe sessions because the participants were taught to emit the component sounds prior to reading the composite word; that is, the participants responded based on how they were taught during the intervention. The results for Participants J and Z support this possibility. When
composite textual responding was modeled at the beginning of the final probe session using the novel word set, both participants emitted significantly more composite only responses than component-followed-by-composite responses. For Participant A, increases in composite only responding occurred in this final probe session, as well. Future research could address these limitations by 1) altering the intervention procedure to include an additional composite responding requirement for each of the word sets and 2) modifying the beginning of the probe sessions such that composite only responding is modeled, rather than component-to-composite responding.

There were several additional limitations, as well. One limitation was the experimental design, which did not control for maturation for the first two participants. Specifically, only one series of pre-intervention probes was conducted for Participant S, and a slightly ascending trend was observed for some of Participant D’s pre-intervention probe results. Moreover, because the probes were derived from Lyons’ (2014), the target words involved only 10 target phoneme-grapheme correspondences; however, because the participants in this experiment textually respond to all phoneme-grapheme combinations, a more comprehensive sample of words and phonemes would have been more appropriate.

Another limitation was that due to the phylogenetic speech issues noted above, Participant Z’s articulation of target words and pseudo-words was unclear at times, during both probe and intervention sessions. For example, he pronounced the word “fleet” as “fleek.” His pronunciation of certain words made it difficult to determine if the response was correct or incorrect. However, IOA was conducted for 80% of his probe sessions to ensure that correct and incorrect responses were consistently distinguished and recorded.
Some procedural differences occurred for Participant Z in the fourth post-BMBI spelling probe. Specifically, the experimenter observed a consistent error pattern; rather than vocally segmenting each of the phonemes in the words, the participant would state the initial and final phonemes in each word and sequence only those phonemes. At the beginning of his fourth post-intervention probe, the participant was instructed to vocally segment each of the phonemes prior to sequencing the letter tiles. Increases in correct spelling responses may have occurred in an earlier post-BMBI probe session with this procedure in place; however, this procedure also impacts the experimenter’s ability to analyze differences in component-to-composite and composite only responding.

In addition to the procedural difference in this spelling probe, there are several potential sources for variances in responding, including differences in instructional histories across the participants and phylogenetic issues, such as articulation errors and sound production with Participant Z. In this sense, multiple causation determined the number of exposures each participant required before an effect was observed.

Additional probes were conducted following the conclusion of the study based on anecdotal evidence that suggested that the reinforcing value of observing printed words may have been enhanced following the intervention. For example, during the later phases of intervention, Participant Z started exchanging his tokens for his “silly words,” or words that comprised mastered intervention sets, throughout the school day. Based on this observation, I conducted a series of probes comparing the duration two of the participants, Participants Z and A, observed five pages of novel printed words and five pages of novel picture stimuli and the duration two peer confederates, who did not participate in the intervention, observed the same words and pictures. These probes are represented in Figure 7 and show that both the participants
who completed the intervention observed words for a longer duration than picture stimuli, and peer confederates observed the pictures for a longer duration. These findings suggested that once an individual can textually respond to a word, observation of or textually responding to that word may come to function as a conditioned reinforcer.

Given these initial findings, as well as the procedural limitations from Experiment 1, a second experiment was conducted to answer the following questions: 1) Does a behavioral momentum blending intervention affect the number of correct textual responses to words comprised of previously mastered phoneme-grapheme correspondences when composite only responding is required as a component of the intervention? 2) Do participants emit more correct composite textual responses than component-to-composite textual responses when composite only responding is incorporated into the intervention? 3) Does the modified behavioral momentum blending intervention increase vocal blends? 4) Does the modified behavioral momentum intervention affect the number of correctly spelled words? 5) Does the behavioral momentum blending intervention affect the reinforcing value of observing printed words?
Figure 7. This figure shows the duration two participants from Experiment 1, Participant Z and Participant A, observed printed words and two-dimensional picture stimuli following intervention, as well as the duration two peer confederates, Peer Confederate 1 and Peer Confederate 2 observed the same word and picture sets during probes conducted at the same time.
Chapter III

EXPERIMENT II

Method

Excluding the sections outlined below, all other components of the methods used in Experiment 2 were identical to those in Experiment 1.

Participants

Six male participants, between three and four years old, participated in Experiment 2. Like the participants in Experiment 1, all the participants in Experiment 2 attended the same CABAS® private, not-for-profit preschool and demonstrated similar cusps, academic and social repertoires, and levels of verbal behavior to the participants in the previous experiments. Excluding Participant T, all the participants were identified as preschoolers with disabilities; Participant T was a neurotypical student. For Participant M, Russian was the primary language spoken at home; however, all the other participants spoke American English as their first and primary. As with the participants in Experiment 1, the participants in the present experiment were selected to participate because they did not textually respond to words comprised of mastered phoneme-grapheme correspondences, even after extensive exposures to direct instruction reading curricula. Additionally, the participants did not attend to printed words and pseudo-words at the same frequency with which they attended to other two-dimensional print stimuli, such as printed pictures. Additional information is provided in Table 9.
Table 9

*Participants’ Verbal Cusps, Capabilities, and Relevant Academic Repertoires for Experiment 3*

<table>
<thead>
<tr>
<th>Participant</th>
<th>Age</th>
<th>Gender</th>
<th>Diagnosis</th>
<th>Relevant Cusps, Capabilities and repertoires</th>
<th>Standardized Test Scores</th>
</tr>
</thead>
<tbody>
<tr>
<td>T</td>
<td>4</td>
<td>Male</td>
<td>Neurotypical</td>
<td>Conditioned reinforcement for faces; conditioned reinforcement for voices; conditioned reinforcement for 3D objects/visual stimuli on desktop and 2D print stimuli; generalized motor imitation; conditioned reinforcement for observing book stimuli; listener literacy; Bi-directional Naming; observational learning; phoneme-grapheme correspondence</td>
<td>Neurotypical- no test scores</td>
</tr>
<tr>
<td>G</td>
<td>4</td>
<td>Male</td>
<td>Preschooler with a disability</td>
<td>Conditioned reinforcement for faces; conditioned reinforcement for voices; conditioned reinforcement for 3D objects/visual stimuli on desktop and 2D print stimuli; generalized motor imitation; conditioned reinforcement for</td>
<td>Batelle Developmental Inventory II - Adaptive 91 - Cognitive 84 - Communication 90 - Motor 75 - Personal-Social 83 Weschler Preschool &amp; Primary Scales of Intelligence IV - Visual Spatial Index 118 (Composite)</td>
</tr>
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<td></td>
</tr>
<tr>
<td><strong>B</strong></td>
<td>4</td>
<td>Male</td>
<td>Preschooler with a disability</td>
<td>Conditioned reinforcement for faces; conditioned reinforcement for voices; conditioned reinforcement for 3D objects/visual stimuli on desktop and 2D print stimuli; generalized motor imitation; conditioned reinforcement for observing book stimuli; listener literacy; Bi-directional Naming; phoneme-grapheme correspondence</td>
<td></td>
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<td></td>
<td></td>
<td></td>
<td>Preschool Language Scale-5</td>
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<td></td>
<td>-Expressive Communication 77</td>
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<td>-Total Language 88</td>
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<td>Batelle Developmental Inventory II</td>
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<td></td>
<td>-Cognitive 89</td>
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<td>-Communication 85</td>
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<td>-Self Help 87</td>
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<td></td>
<td>-Social/Emotional 81</td>
<td></td>
</tr>
<tr>
<td><strong>M</strong></td>
<td>3</td>
<td>Male</td>
<td>Preschooler with a disability</td>
<td>Conditioned reinforcement for faces; conditioned reinforcement for voices; conditioned reinforcement for 3D objects/visual stimuli on desktop and 2D print stimuli; generalized motor imitation; conditioned reinforcement for observing book stimuli; listener literacy; Bi-directional Naming; phoneme-grapheme correspondence</td>
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<td></td>
<td></td>
<td>Weschler Preschool &amp; Primary Scales of Intelligence IV</td>
<td></td>
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<td></td>
<td></td>
<td></td>
<td></td>
<td>-Verbal Comprehension 103</td>
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<td>Weschler Preschool &amp; Primary Scales of Intelligence IV</td>
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<td></td>
<td>-Full Scale 112</td>
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<td></td>
<td>-Verbal Comprehension 98</td>
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<td></td>
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<td>-Working Memory 121</td>
<td></td>
</tr>
<tr>
<td>P</td>
<td>3</td>
<td>Male</td>
<td>Preschooler with a disability</td>
<td>Conditioned reinforcement for faces; conditioned reinforcement for voices; conditioned reinforcement for 3D objects/visual stimuli on desktop and 2D print stimuli; generalized motor imitation; conditioned reinforcement for observing book stimuli; listener literacy; Bi-directional Naming; observational learning; phoneme-grapheme correspondence</td>
<td></td>
</tr>
</tbody>
</table>
| Batelle Developmental Inventory II  
- Adaptive 87  
- Cognitive 84  
- Communication 85  
- Motor 100  
- Personal-Social Development 85  
  
Preschool Language Scale 5  
- Auditory  
Comprehension 79  
- Expressive  
Comprehension 80  
  
Weschler Preschool & Primary Scales of Intelligence IV  
- Full Scale 106  
- Verbal Comprehension 95  
- Visual Spatial 106  
  
Developmental Assessment of Young Children II  
- Adaptive Behavior 80 |
| J  | 3  | Male | Preschooler with a disability | Conditioned reinforcement for faces; conditioned reinforcement for voices; conditioned reinforcement for 3D objects/visual stimuli on desktop and 2D print stimuli; generalized motor imitation; conditioned reinforcement for observing book stimuli; listener literacy; Bi-directional Naming; observational learning; phoneme-grapheme correspondence |  
| Batelle Developmental Inventory II  
- Adaptive 87  
- Cognitive 84  
- Communication 85  
- Motor 100  
- Personal-Social Development 85  
  
Preschool Language Scale 5  
- Auditory  
Comprehension 79  
- Expressive  
Comprehension 80  
  
Weschler Preschool & Primary Scales of Intelligence IV  
- Full Scale 106  
- Verbal Comprehension 95  
- Visual Spatial 106  
  
Developmental Assessment of Young Children II  
- Adaptive Behavior 80 |
reinforcement for 3D objects/visual stimuli on desktop and 2D print stimuli; generalized motor imitation; conditioned reinforcement for observing book stimuli; listener literacy; Bi-directional Naming; phoneme-grapheme correspondence

-Cognitive Development 78
-Expressive Communication 81
-Fine Motor Development 86
-Gross Motor Development 82
-Receptive Communication 81

Preschool Language Scale 5
-Auditory Comprehension 79
-Expressive Communication 80
-Total Language Score 78

Note. The cusps and capabilities listed above are derived from Verbal Behavior Development theory, which suggests that an individual’s behavioral development is directly linked to the acquisition of conditioned social reinforcers; in this case, reader behavior emerges following the acquisition of the relevant cusps listed herein. The Preschool Language Scale-5 is an interactive assessment of developmental language skills that involves pointing and vocally responding to pictures and objects. The Batelle Developmental Inventory II is a developmental assessment for young children that screens and evaluates early childhood developmental milestones. The Weschler Preschool & Primary Scales of Intelligence IV is an intelligence test for children ages 2 to 7 that measures cognitive development. The Developmental Assessment of Young Children is a test used to identify children from birth through age 5 with possible developmental delays related to cognition, communication, social-emotional development, physical development, and adaptive behavior. All scores are reported as standard scores.
Setting and Materials

For Experiment 2, all probe and intervention sessions occurred in the participants’ integrated classroom. The classroom included twelve child-sized desks used for instruction, a circular yellow table also used for instruction, and plastic child-sized chairs. There were up to 15 students and four adults in the classroom at any given time, and as with the previous experiment, the other adults and students in the classroom were engaged in daily instructional activities while intervention occurred.

Materials used during pre- and post-BMBI probe sessions were the same as the previous experiment. In addition, for the additional dependent variable related to conditioned reinforcement for observing printed words, the experimenter presented five 8” x 10” laminated sheets of paper with 15-20 pictures of two-dimensional stimuli and five 8” x 10” laminated pages with 15-20 novel printed words and pseudo-words.

During intervention sessions, the experimenter presented the target words on 8” by 10” sheets of paper, with one word printed in the middle of each page in size 72 Comic Sans font. The words were contained in a red 1” thick binder and the page was turned each time the participant textually responded to word, mimicking the experience of book reading. In addition, during fluency phases, words were printed on a single 8” x 10” sheet of paper, with four words per line, and five lines of text. This format allowed for true free operant responding during fluency sessions; that is, the experimenter’s management of the index cards no longer interfered with the participant’s rate of responding.

Dependent Variables
The dependent measures used in Experiment 2 were identical to the measures used in the previous experiment. However, the novel words used in the final probe session for textual responding in Experiment 1 were used as the primary set of words in the probe sessions in this experiment (Table 5); similarly, the novel words used for the vocal blending probes in Experiment 1 were used as the primary set in Experiment 2 (Table 6). An additional set of novel words, created for this experiment, was used for the final probe sessions for all measures (Tables 10 and 11). In addition to the dependent measures used in Experiment 1, the participants also took part in pre- and post-BMBI probes on the duration they observed printed words and printed pictures.

**Conditioned reinforcement for observing printed words.** To determine if novel printed words and pseudo-words were conditioned as reinforcers, pre- and post-probes were conducted following every two phases of the intervention. Probes for conditioned reinforcement for observing printed words were conducted in a similar manner to the probes for observing two-dimensional print stimuli outlined in Keohane et al. (2009). During the pre- and post-BMBI probes, the participants were presented with five different 8” x 10” pages of 15-20 novel printed words comprised of up to five phonemic sounds, and five different pages of 15-20 two-dimensional pictures of known stimuli. Words printed on the probe pages were not taught during the intervention sessions. Figure 8 shows the pages of printed words and pictures used during the probes. The ten different pages were presented one at a time, alternating between pages of printed words and pages with pictures, and the experimenter timed the duration that the participants looked at each page, including responses in which the participants read the words aloud. When the participant looked away from the page for 3 s, the timer was stopped. After all ten pages of printed words and pictures were presented individually, the experimenter totaled the
cumulative duration the participants observed the pages with words and the cumulative duration the participants observed the pages with pictures.

**Independent Variable**

Based on the data collected in Experiment 1, an additional step was added to the intervention sequence in Experiment 2. Following two correct consecutive responses with learn unit instruction for component-to-composite blending, instruction shifted to learn unit instruction for composite only responding. Under this condition, the experimenter directed the participant to, “Read the whole word,” and the participant was required to textually respond to the composite word. Incorrect responses consisted of component-to-composite responses, incorrect composite responses, and failure to respond. This represented the final step in the instructional sequence. As with the preceding steps in the sequence, if the participant emitted two consecutive incorrect responses, the experimenter shifted back to the previous step involving learn unit instruction for component-to-composite responding. Figure 1 shows the sequence of instructional steps for the intervention, including the final step outlined here. Sets of words continued to be counterbalanced across participants, as in Experiment 2 (see Table 12).

**Interobserver Agreement**

Interobserver agreements were collected and calculated in the same manner as Experiment 1. For Participant T, IOA was collected for 70% of probe sessions. Agreement ranged between 93% and 100%, with a mean percentage of agreement of 99%. For Participant G, 70% of sessions were conducted with IOA, for Participant M, 62% of sessions were conducted with IOA, for Participant B, 85% of sessions, with 100% agreement each time across participants. For Participant P, 75% of probe sessions were conducted with IOA with a range of
92% to 100% and a mean percentage of agreement of 99%. For Participant W, IOA was collected for 23% of sessions with 100% agreement.
Figure 8. Figure 8 shows the pages used during the pre- and post-BMBI probes conducted to determine if printed words were conditioned as reinforcers. During the probes, the participants were presented with five different pages of novel printed words and five different pages of two-dimensional pictures of known stimuli.
Table 10

60 words and pseudo-words used for novel set in Experiment 2

<table>
<thead>
<tr>
<th>Sup</th>
<th>Bat</th>
<th>at</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hap</td>
<td>Sid</td>
<td>tat</td>
</tr>
<tr>
<td>Dit</td>
<td>Zit</td>
<td>putt</td>
</tr>
<tr>
<td>Sad</td>
<td>Tad</td>
<td>hill</td>
</tr>
<tr>
<td>Tub</td>
<td>Sith</td>
<td>mid</td>
</tr>
<tr>
<td>Mass</td>
<td>Dis</td>
<td>pug</td>
</tr>
<tr>
<td>Tee</td>
<td>Tam</td>
<td>ris</td>
</tr>
<tr>
<td>Ric</td>
<td>Bic</td>
<td>cad</td>
</tr>
<tr>
<td>Glib</td>
<td>Rit</td>
<td>zap</td>
</tr>
<tr>
<td>Sac</td>
<td>Jolt</td>
<td>rac</td>
</tr>
<tr>
<td>Mist</td>
<td>Cast</td>
<td>tast</td>
</tr>
<tr>
<td>Brot</td>
<td>Stric</td>
<td>rist</td>
</tr>
<tr>
<td>Thad</td>
<td>Thim</td>
<td>flint</td>
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<td>Seet</td>
<td>Ween</td>
<td>glut</td>
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<td>Frat</td>
<td>Slot</td>
<td>preen</td>
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<tr>
<td>Seer</td>
<td>Deed</td>
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<tr>
<td>Stam</td>
<td>Trad</td>
<td>stad</td>
</tr>
<tr>
<td>Tham</td>
<td>Thist</td>
<td>trust</td>
</tr>
<tr>
<td>Ping</td>
<td>Grim</td>
<td>split</td>
</tr>
<tr>
<td>Tree</td>
<td>Teeth</td>
<td>sreeth</td>
</tr>
</tbody>
</table>

*Note. Words in bold were used for spelling probes*
Table 11

20 words used during novel set post-intervention vocal blending probes in Experiment 2

<table>
<thead>
<tr>
<th>Sad</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tee</td>
</tr>
<tr>
<td>Sac</td>
</tr>
<tr>
<td>Brot</td>
</tr>
<tr>
<td>Seer</td>
</tr>
<tr>
<td>Ping</td>
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<tr>
<td>Dis</td>
</tr>
<tr>
<td>Rit</td>
</tr>
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<td>Cast</td>
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<tr>
<td>Thim</td>
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<tr>
<td>Thist</td>
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<tr>
<td>Teeth</td>
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<tr>
<td>Bic</td>
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<td>Grid</td>
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<td>Zap</td>
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<tr>
<td>Tast</td>
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<tr>
<td>Glut</td>
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<tr>
<td>Preen</td>
</tr>
<tr>
<td>Stad</td>
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<tr>
<td>Split</td>
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</tbody>
</table>
Table 12

Counterbalanced sets of target words and non-words during Experiment 2 across participants.

<table>
<thead>
<tr>
<th>Participant</th>
<th>Phase 1</th>
<th>Phase 2</th>
<th>Phase 3</th>
<th>Phase 4</th>
</tr>
</thead>
<tbody>
<tr>
<td>T</td>
<td>4</td>
<td>6</td>
<td>5</td>
<td>2</td>
</tr>
<tr>
<td>G</td>
<td>3</td>
<td>5</td>
<td>6</td>
<td>1</td>
</tr>
<tr>
<td>M</td>
<td>1</td>
<td>2</td>
<td></td>
<td></td>
</tr>
<tr>
<td>B</td>
<td>6</td>
<td>4</td>
<td>1</td>
<td>3</td>
</tr>
<tr>
<td>P</td>
<td>2</td>
<td>3</td>
<td></td>
<td></td>
</tr>
<tr>
<td>W</td>
<td>5</td>
<td>1</td>
<td></td>
<td></td>
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</tbody>
</table>
Results

The first two research questions addressed in Experiment 2 considered if a modified BMBI procedure that incorporated composite only responding would affect the number of correct textual responses the participants emitted, as well as component-to-composite versus composite only textual responding. Figure 9 represents the number of correct component phonemes followed by correct textual responses to words as well as the number of correct composite responses for all six participants in Experiment 2. None of the participants emitted any correct textual responses during pre-intervention probe sessions, except for Participant W, who emitted 1 correct response in the second and third pre-BMBI probes. Following the first two phases of intervention, Participant T emitted 47 correct responses, Participant G emitted 46 correct responses, Participant B emitted 7 correct responses, Participant M emitted 6 correct responses, Participant P emitted 31 correct responses, and Participant W emitted 36 correct responses. All participants emitted more component-to-composite responses than composite only responses. Following an additional two phases of intervention, Participants T and G emitted 56 and 57 responses, respectively. Both component-to-composite and composite only responding were observed. In an additional probe conducted with a novel set of words and pseudo-words, Participant T emitted 28 component-to-composite responses and 23 composite only responses, for a total of 51 correct responses, and Participant G emitted 11 component-to-composite responses and 47 correct composite only responses, with a total 58 correct responses. In his second post-intervention probe, Participant B emitted 20 correct responses, all of which involved component-to-composite responding. For Participants M, P, and W, only one series of post-intervention probes were conducted.
The third research question addressed the effects of the modified BMBI procedure on the production of vocal blends. Figure 10 shows the number of correct vocal blending responses the participants emitted during Experiment 2. None of the participants emitted any correct vocally blended responses during the pre-BMBI probe sessions. During the first post-BMBI probe, Participant T emitted 17 correct responses, Participant G emitted 19 correct responses, Participant B emitted 20 correct responses, Participant M emitted 11 correct responses, Participant P emitted 18 correct responses, and Participant W emitted 16 correct responses. In the second post-BMBI probe, Participants T, G, and B emitted 20/20 correct responses; Participants T and G emitted 20 correct responses when a probe was conducted with novel words, as well.

The fourth research question asked if the modified BMBI procedure would affect the accuracy of spelling responses. Figure 11 shows the number of correct spelling responses the participants emitted with and without emitting the component phonemes prior to spelling the composite word. The participants did not emit any correct responses prior to the intervention. Following the first two phases of intervention, Participant T emitted 11 correct spelling responses, Participant G emitted 14 correct responses, and Participants B and M did not emit any correct spelling responses. Participant P emitted 8 correct spelling responses in his first post-intervention probe and Participant W emitted 4 correct responses. Participants T, G, and P all emitted more component-to-composite spelling responses than composite only responses; of the 4 correct responses Participant W emitted, all 4 were composite responses. Following two additional intervention sets, Participant T emitted 14 correct responses and Participant G emitted 17 correct responses, with composite only responding increasing for both participants. Participant B did not emit any correct responses during his second post-intervention probe. In the final probe session, using a set of novel words, Participant T emitted 15 correct responses, all
composite only, and Participant G emitted 16 correct composite only responses and 2 correct component-to-composite responses.

The final research question addressed a new variable: does BMBI alter the reinforcing value of observing printed words? Figure 12 represents the cumulative duration the participants observed picture stimuli and printed words prior to and following the blending intervention. Three pre-intervention probes were conducted for Participants T, G, M, and B to establish steady state responding. During his pre-BMBI probe sessions, Participant T observed the pages of pictures for 101, 107, and 76 s respectively, and he observed the pages with words for 24, 79, and 68 s respectively across the sessions. Following the first two phases of intervention, Participant T observed the pages with pictures for 62 s and the pages with printed words for 146 s. Participant G observed pages of pictures for 206, 193, and 48 s across his three pre-intervention probes, and pages of words for 56, 65, and 33 s. In his first post-BMBI session, he observed pictures for 205 s and words for 355 s. In his second post-BMBI session, the duration he observed pictures decreased to 197 s and the duration he observed printed words increased significantly to 534 s. Both Participants B and M continued to observe pictures for a longer duration than words following intervention. Participant B observed pictures for 76, 218, and 163 s in his pre-intervention probes, and he observed the printed text for 33, 58, and 38 s across the sessions. Following two phases of intervention, he observed pictures for 311 s and printed words for 64 s. In his pre-BMBI probes, Participant M observed picture stimuli for 163, 142, and 142 s and he observed printed words for 35, 41, and 34 s. During the first post-intervention probe, he observed picture stimuli for 129 s and printed words for 122 s. Both Participants P and W observed pictures for a longer duration than words during pre-intervention probe sessions. Following the first two phases of intervention, Participant P continued to observe pictures longer
than he observed words (116 s as compared to 68 s), while Participant J observed words for slightly longer (201 s as compared to 239 s).

Figures 13 and 14 represent the intervention data collected for the participants in Experiment 2 across mastery and fluency phases of behavioral momentum blending. As with the participants in Experiment 1, the participants received a varying number of intervention sessions.
Figure 9. Figure 9 shows the number of correct textual responses emitted with component phonemes and the number of correct composite textual responses to words and pseudo-words comprised of previously mastered phoneme-grapheme correspondences during pre- and post-behavioral momentum blending intervention probe sessions in Experiment 2.
Figure 10. Figure 11 shows the number of correctly blended phonemes the participants emitted during pre- and post-behavioral momentum blending intervention probe sessions in Experiment 2.
Figure 11. Figure 11 shows the number of correct spelling responses with and without overtly emitted component phonemes to words and pseudo-words comprised of previously mastered phonemes during pre- and post-behavioral momentum blending intervention probe sessions in Experiment 2.
Figure 12. Figure 12 shows the cumulative duration in s that participants observed five pages of 15-20 two-dimensional pictures and five pages of novel printed words and pseudo-words during pre- and post-behavioral momentum blending intervention probe sessions in Experiment 2.
Figure 13. This figure shows the number of correct responses the participants emitted during Behavioral Momentum Blending Intervention (BMBI) sessions to teach the word sets to mastery in Experiment 2.
Figure 14. This figure shows the rate of correct and incorrect textual responses emitted by the participants in Experiment 2 during the fluency phases of intervention.
Discussion

The results for at least four of the six participants replicate those obtained in the previous experiment. Participants T, G, P, and W textually responded to words and pseudo-words with significantly greater accuracy following four or fewer phases of intervention, although Participants P and W did not textually respond at criterion level during the one series of post-intervention probes conducted. Significant increases in vocal blending and spelling responses were observed, as well. Participants M and B emitted only slightly more correct textual responses following the first two to four phases of intervention, although significant increases in vocal blending were observed. The results mirror those obtained in Experiment 1, which showed that all the participants acquired vocal blending prior to, or at the same time as, they acquired accurate textual responding. Participant Z, for example, required several phases of BMBI before substantial increases in correct textual responding and spelling were observed in Experiment 1. Likewise, for Participants M, B, P, and W it appears that additional exposures to the intervention may be necessary. Participant M only emitted 11/20 correct vocal blends during the first post-intervention probe, which may be related to his history speaking Russian outside of school. Given previous findings, textual responding may not be possible until accurate vocal blending is established.

As in Experiment 1, all participants initially emitted more correct responses when they emitted the component phonemes first; however, both Participants T and G demonstrated increases in correct composite textual responses in the second post-intervention probe, when approximately half of their correct responses were composite only. These results differ from Experiment 1, where all but one participant emitted more component-followed-by-composite responses across the probe sessions, at least until composite only responding was modeled at the
beginning of the probes. These findings suggest that component-to-composite responding might be a prerequisite for learning to respond to print at the whole word level.

The results from Experiment 2 also suggest that at least for the first two participants, the modifications to the intervention to require composite only responding as the final step in the instructional sequence might have facilitated transformation of stimulus function, whereby the participants derived relations between the letter sounds, the spoken word, and the printed word at the covert level. Another possible explanation for the differences in responding across participants in the two experiments is that the participants in Experiment 1 were taught to emit component-to-composite during the procedure and might have simply responded as they had been taught during the probe sessions. The expectations that had been reinforced during instruction affected the behavior observed during the probes.

The results from the measure of conditioned reinforcement for observing print warrant some discussion. Participants T, G, and W observed print for longer durations than they observed pictures following the intervention, while Participants M, B, and P continued to observe the two-dimensional pictures for a longer duration than the text. These results parallel the results obtained on the textual responding measure to some degree. Once the participants textually responded accurately to words, increases in the observation of words increased commensurately. In this sense, a change in the reinforcing value of the printed words occurred, as evidenced by the development of resistance to extinction. For Participants M and B, who textually responded to words with significantly less accuracy, this shift in reinforcing value has not yet occurred. Participant P may require additional exposures, as well.

Future research may want to reconsider the measurement used as a barometer for the reinforcing value of printed words. While this experiment solely considered the observation of
print, both Participants T and G textually responded to the words during the post-intervention probes, rather than simply scanning the page, or passively “observing.” Even when textual behavior was not fluent, and the participants continued to emit composite-to-component responses, they read the words. Similarly, when presented with the two-dimensional pictures, all the participants emitted tacts related to the pictures, vocally stating the names of each of the images. Perhaps once the function of textual behavior is acquired, the behavior cannot be suppressed, much like speaker behavior in the presence of a known object and an enthusiastic audience.
Chapter V

GENERAL DISCUSSION

In two experiments, I tested for a) the effects of a Behavioral Momentum Blending Intervention (BMBI) on the accuracy of textual responses, vocally blended responses without text, and spelling responses emitted by preschoolers, b) the differences in component versus composite textual responding, and c) the acquisition of conditioned reinforcement for observing printed words.

In Experiment 1, I found that following BMBI, participants emitted more correct textual, vocally blended, and spelling responses than they did prior to the intervention. Furthermore, the experiment demonstrated differences in the types of textual and spelling responses the participants emitted. As with Lyons’ (2014) study on blending, two types of responding were observed: responses in which the participants emitted the component phonemes in the word prior to emitting, or producing, the composite responses, and responses in which the participant emitted or produced the composite word only. These findings support Lyons’ argument that textual responding may involve various levels of speaker-as-own-listener behaviors; that is, when learning to read, individuals may first need to acquire a speaker-as-own-listener repertoire that involves listening to their own production of component sounds at the overt level, prior to emitting the correct textual response. Once present, Lyons (2014, p. 97) contends that “the ease of execution of blending” allows this behavior to become covert.

With the latter three participants in Experiment 1, I sought to account for differences in component versus composite responding by modifying the probe procedure following the demonstration of accurate textual responding. For these participants, I modeled composite only responding for two exemplars prior to requiring the participants to respond in the final probe
session for textual responding with novel words; in previous probe sessions, component-to-composite responding was modeled. Results during this final probe session showed that participants emitted more correct composite only responses than they did during the previous probe sessions. This suggested that component-to-composite responding might have occurred as a function of the intervention procedure; participants responded as they had been trained to respond, until they were trained or taught to respond at the whole word level.

Experiment 2 sought to further investigate sources for component versus composite responding by altering the intervention procedure to require composite only responding as the final step in the training sequence and by modeling composite only responding at the onset of the probe sessions for textual responding. Results continued to support Lyons’ (2014) claim in that her participants emitted more component-to-composite responses initially, and as the intervention progressed, composite only responding emerged. Thus, participants learned to respond to their own speaker behavior at the overt level before blending became a covert response.

Experiment 2 also tested the effects of BMBI on the establishment of conditioned reinforcement for observing printed words. Results showed that as participants textually responded with greater accuracy, the duration they observed printed words increased commensurately. These findings supported the hypothesis that when textual behavior emerges, the correspondence between the spoken (either overtly or covertly) sounds in words and the text itself acquires reinforcing properties for observing responses.

**Major Findings**

**Component and Composite Responding.** The findings from Experiments I and II provide evidence that the establishment of a textual responding repertoire involves the
acquisition of speaker-as-own-listener responding at, at the very least, two levels. In both experiments, participants demonstrated component-to-composite responding prior to responding at the whole word level, suggesting that individuals must first learn to listen to their own production of component sounds overtly to blend those sounds into a word before the behavior of blending becomes covert. These findings support Lyons’ (2014) study in which she identified two types of participants: individuals who emitted the component phoneme-grapheme relations prior to emitting the correct composite textual response, and individuals who emitted the composite textual response without emitting the component phonemes first. As with other speaker-as-own-listener repertoires, cusps, and capabilities, such as Bi-directional Naming, a blending repertoire may involve initially independent speaker and listener repertoires that come to be joined through a rotation across listener and speaker responses using multiple exemplars, first at the overt level, then subsequently, becoming covert responses. In this sense, blending initially occurred as a rule-governed behavior.

Results garnered from both experiments validate Skinner’s analysis of minimal textual units and the arrangement of instruction to derive novel textual relations using these units, such as that which was described by Alessi (1987). It appears that by teaching a general pattern of responding, in this case emitting component phoneme-grapheme relations prior to composite word reading, participants learned to emit effective responses to untrained relations, as evidenced by the increases in correct textual and spelling responses using novel sets of words. Alessi (1987) contended that by using general case teaching strategies, individuals learn essential stimulus control (i.e., abstraction) by responding to the common properties of stimuli while not responding to the irrelevant dimensions of those stimuli. In this sense, the rotation of exemplars
may have taught a specific pattern of component-to-composite responding that was necessary in
the establishment of a textual responding repertoire.

**Hierarchy of Blending Repertoires.** A developmental trajectory along which types of
blending responses emerged was observed across all the participants in the two experiments and
is represented in Figures 15 and 16. Across all participants, vocally blended responses without
text emerged prior to or simultaneously with textual and spelling responses. In addition,
conditioned reinforcement for observing printed words and textual responding emerged at the
same time. Consistently, spelling was the last repertoire to emerge.

These findings are consistent with research related to Verbal Behavior Development
Theory, which argues that listener and speaker repertoires develop independently and join later
to produce higher level cusps, capabilities, and repertoires that involve speaker-as-own-listener
responding (Greer & Speckman, 2009). Vocal blending without print required the participants to
respond independently as both listeners and speakers; that is, they were required to listen to
another individual’s speaker behavior to emit the correct composite response. Textual responding
and spelling, in turn, required speaker-as-own-listener behavior.

**Conditioned Reinforcement for Observing Printed Words.** In addition to the
methodological changes made to refine the potential limitations of the first two experiments,
Experiment 2 also considered the acquisition of new conditioned reinforcers related to textual
responding following the establishment of a blending repertoire. These findings upheld the
supposition that once participants textually responded by blending, printed words selected out
their observing responses, suggesting a change in the reinforcement value of responding to the
printed text. Moreover, although the target behavior of “observing” the text did not require the
participants to read the words on the pages presented, all the participants with textual responding
repertoires attempted to read the printed words; that is, there was a greater resistance of textual responding to extinction, further supporting the argument that the correspondence between overt and covert segmenting and blending, or “saying the sounds,” and the text itself had acquired reinforcing properties. For individuals who are fluent readers, this phenomenon may not be surprising; we read words whether we intend to or not once textual behavior is present.

Given these findings, the argument for blending as a verbal behavior developmental cusp is two-fold. Greer and Speckman (2009) define verbal developmental cusps as developmental milestones that allow children to learn things they could not learn prior to the acquisition of the cusp and make it possible to contact new contingencies and new conditioned reinforcers. In the case of a blending repertoire, the participants learned to textually respond to words they could not respond to prior to learning how to blend. Reader behavior emerged only after blending had been established. Furthermore, once the participants could blend, they observed printed text for equal, and often longer, durations than they observed two-dimensional pictures of known stimuli. This shift in reinforcement value may facilitate the acquisition of additional conditioned reinforcers related to reading, such as conditioned reinforcement for reading content, first at the individual word level, and later, with larger chunks of text.

**Limitations**

**Experiment 1.** There were some limitations in the first experiment. One limitation was that only one pre-intervention probe was conducted for Participant S across the three dependent measures prior to intervention. Because there was only one probe, it is impossible to determine the pattern of responding before the intervention or to evaluate if the observed effects occurred as a function of the intervention. Additionally, Experiment 1 did not control for steady state
responding with Participant D and there were some slight increases in the number of correct spelling responses prior to intervention.

**Experiment 2.** Experiment 2 was not without limitations, as well. The most salient limitation is the small number of post-intervention probes conducted for Participants B and M. As evidenced with participants in Experiment 1, the number of intervention sessions required until participants textually responded at criterion level varied substantially across participants due to factors of multiple causation; like the participants in Experiment 1, Participants B and M may need to participate in additional phases of intervention before significant differences in textual responding and spelling occur. However, due to time constraints, additional sessions could not be conducted prior to the completion of Experiment 2.

**Future Research**

Several studies have indicated that it is possible to make good predictions about the reading outcomes of individual children, including children as young as kindergarteners (Catts, Fey, Zhang, & Tomblin, 2001; Elbro, Borstrom, & Petersen, 1998; Torgesen, Wagner, & Rashotte, 1994). These predictions can be made by evaluating demographic information, socioeconomic status and parental education, as well as by assessing the individual’s oral language production, or, from a behavioral perspective, his or her speaker behavior. Accurate echoic behavior, for example, is critical to the production and manipulation of even the smallest phonemic units. Therefore, for children with specific deficits in speaker behavior, such as children with disabilities, it is imperative that interventions that address speaker responding are developed and incorporated into both language and reading instruction beginning at an early age. Given this information and the findings garnered from the experiments presented herein, future research should arrange instruction so that students have ample opportunities to respond as
listeners and speakers to their own textual responses, even at the single sound level, in addition to responding to another individual’s production of the units. In contrast, the significance of the behavior momentum blending antecedent remains unclear. Perhaps, the antecedent expedited the acquisition of vocally blended responses thereby expediting the subsequent acquisition of textual responses. Perhaps, the rotation of responding as a listener, speaker, and speaker-as-own-listener was the key component of the procedure. Future research may want to compare outcomes for participants who do not receive the behavioral momentum antecedent to those who do.

Additionally, future research may benefit from considering some of the variables that could account for the differences in responding across the participants, including the wide-ranging number of sessions required to demonstrate criterion level textual responding. For instance, while all the participants textually responded to all 44 phoneme-grapheme combinations prior to intervention, the experimenter did not assess the fluency of responding to the letter sounds during participant selection, which may have been a considerable oversight. Experimenters looking to replicate these findings might maximize results and minimize the duration of intervention by controlling for letter-sound fluency.

Given Lyons’ (2014) previous findings using an auditory matching of component sounds to composite words procedure, future research may also want to consider a comparison of the effects of the Behavioral Momentum Blending Intervention (BMBI) and the auditory matching intervention described in Lyons’ study on the accuracy of textual and spelling responses emitted by students who are learning to read. Additionally, future researchers may want to consider the utility of the procedure in the classroom or as a redesigned element of Direct Instruction. Lyons’ procedure, for example, involved a progression through ten phases of intervention, whereas most of the participants in this study required fewer than ten phases of intervention to demonstrate
significant differences in responding on reading and spelling measures. However, because Lyons did not describe the total number of sessions required to complete the intervention, it is impossible to determine if one procedure is more time-consuming than the other without additional investigation.

**Educational Implications**

Within the field of reading research, there has been widespread agreement that blending and segmenting the sounds that comprise words are critical components of a proficient reading repertoire, particularly for young readers (Daly et al., 2004). Skills related to sound manipulation, letter-sound correspondence, and using letter-sound correspondences to read words are all strong predictors of reading achievement by the end of first grade (Ehri & Sweet, 1991). Results from the present study suggest that given multiple opportunities to blend and segment letter sounds in words, students may learn to read and spell words phonetically. These findings substantiate the conclusions from earlier educational and behavioral-based studies emphasizing the significance of blending and segmenting in learning to read (Daly et al., 2004; Lyons, 2014).

Considering the shift from overt to covert responding observed in this study as well as Lyons’ (2014) study, explicit blending and segmenting instruction, in which vocal blending and segmentation is overtly modeled, might be necessary for students who are struggling to textually respond to regular words. Several participants in the present study, for example, insisted on “saying the sounds” prior to textually responding to novel words, particularly during the early stages of the intervention. By overtly segmenting the sounds in the words, the participants learned to listen to their own speaker responses and hear the composite target response. This component-to-composite instruction taught the participants a specific skill they could employ
when they were required to read an unknown word. For young readers who encounter a multitude of new words daily, this instruction provides one method for accurate textual responding, especially when transformation of stimulus control to the whole word has not yet occurred.

The Behavioral Momentum Blending Intervention facilitated the acquisition of different production responses related to literacy, as well. Participants learned to spell words accurately in addition to reading them accurately, even though spelling was not a behavior that was directly taught. These findings suggest that by teaching students to segment and blend the component phoneme-grapheme correspondences in words, students can acquire collateral behaviors related to reading and writing; in other words, segmenting and blending may facilitate the acquisition of transformation of stimulus function. Ehri (2000) described a reciprocal relationship between reading and spelling; however, perhaps it is the reciprocity between blending and segmenting that makes possible the establishment of both types of responding.

Conclusion

In two experiments, I tested for a) the effects of a Behavioral Momentum Blending Intervention (BMBI) on the accuracy of textual responses, vocally blended responses without text, and spelling responses emitted by preschool students, b) differences in component and composite responding as a potential function of probe and intervention procedures, and c) the acquisition of conditioned reinforcement for observing printed words. The present study demonstrates the effectiveness of BMBI on increasing accurate textual and spelling responses by blending phonetically for students with blending difficulties as well as those with few to no reader repertoires. These increases may be due to the rotation across listener, speaker, and speaker-as-own-listener responses using multiple exemplars that are embedded in the
intervention, or it may be that the behavioral momentum antecedent allowed for the first
instances of vocal blending, from which blending to textually respond became a contingency-
shaped response. The results of the present investigation also substantiated Lyons’ (2014) earlier
claims that segmenting and blending are behaviors that occur at the overt level prior to becoming
covert, as is the case with other speaker-as-own-listener behaviors, such as self-talk. Moreover,
the findings suggest that there may be a hierarchy involved in learning to blend to read words;
results showed that all participants acquired vocal blending prior to, or in conjunction with,
textual responding, while spelling was consistently the last repertoire to emerge. These findings
mirror the shift from listener or speaker to speaker-as-own-listener that appears to occur when
learning to blend and substantiate earlier findings that listener behavior emerges prior to speaker
and speaker-as-own-listener responding. Finally, results from Experiment 2 signaled a change in
the reinforcing value of how individuals respond to printed words once textual responding is
possible, indicating that blending individual sounds into words, first vocally and later with print,
may qualify as a verbal behavior developmental cusp. As described throughout this paper,
reading is perhaps the most significant predictor of successful academic and professional
outcomes and students who fall behind in reading as early as kindergarten or first grade often fail
to “catch up.” Results from these studies suggest that these students may be missing a critical
speaker-as-own-listener cusp related to blending and that instruction that rotates across listener
and speaker responses, such as BMBI, may be powerful in joining the two types of responding
and bringing them under the control of textual stimuli.
Figure 15. This figure shows results across all participants from Experiment 1 during post-BMBI probe sessions. Empty slices within the pie chart indicate less than 80% responding for the textual responding, vocal blending, and spelling responses. For conditioned reinforcement for observing printed words to be present, the participants needed to observe the pages of printed words for an equal duration, or longer duration, than they observed pages of two-dimensional picture stimuli. Conditioned reinforcement for observing print was not measured for the first three participants.
Figure 16. This figure shows results across all participants in Experiment 2 during post-BMBI probe sessions. Empty slices within the pie chart indicate less than 80% responding for the textual responding, vocal blending, and spelling responses. For conditioned reinforcement for observing printed words to be present, the participants needed to observe the pages of printed words for an equal duration, or longer duration, than they observed pages of two-dimensional picture stimuli.
References


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