The Role of Conditioned Seeing on Reading Outcomes for Students in Kindergarten through Second Grade

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Submitted in partial fulfillment of the
requirements for the degree of
Doctor of Philosophy
under the Executive Committee
of the Graduate School of Arts and Sciences

COLUMBIA UNIVERSITY

2022

Abstract

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In 2 experiments, I investigated the role of conditioned seeing on incidental bidirectional naming (Inc-BiN) for unfamiliar stimuli and reading achievement. In Experiment 1, I investigated the correlation, associations, and differences between conditioned seeing, Inc-BiN, and measures of reading achievement for 49 participants in kindergarten through second grade. Unfamiliar visual stimuli were presented with spoken words during a naming experience and participants' stimulus control for conditioned seeing was measured by drawing responses in the absence of the target stimuli. Reading achievement measures included Winter and Spring diagnostic scores from the *iReady® K-12 Adaptive Reading* diagnostic (Curriculum Associates, LLC, 2017). Pearson's correlation analyses showed that participants' stimulus control for conditioned seeing was significantly correlated with all measures of reading achievement and the stimulus control for untaught listener responses (Inc-UniN), $r\ (47) = .440$, $p = .002$, and untaught speaker responses (Inc-BiN), $r\ (47) = .384$, $p = .007$. A Spearman's rank correlation test showed that participants' performance percentile for the *iReady®* reading diagnostic was also significantly correlated with participants' stimulus control for conditioned seeing. Lastly, results from the independent sample t-tests showed that there were significant differences in participants' stimulus control for Inc-UniN and Inc-BiN and reading achievement as a function of low and high stimulus control for conditioned seeing. Experiment 1 established the need to further investigate conditioned seeing and its effects on reading comprehension and Inc-BiN for students in kindergarten through second grade, thus in Experiment 2, I investigated the effects of a multiple exemplar instruction

(MEI) across delayed selection and production responses intervention on the establishment of conditioned seeing for 6 kindergarten students. Furthermore, I investigated the effects of the establishment conditioned seeing on reading comprehension, conditioned reinforcement for books without pictures, and Inc-BiN. Results show that the MEI across delayed selection and production responses was effective in establishing conditioned seeing for all participants. Results further show that the establishment of conditioned seeing resulted in increases in measures for reading comprehension and the reinforcement value for books without pictures. Though the establishment of conditioned seeing did not establish Inc-BiN for participants, Experiment 2 demonstrates the need to further investigate the relation between conditioned seeing and Inc-BiN in young readers.

Keywords: conditioned seeing, incidental bidirectional naming, reading comprehension, reader-as-own-listener repertoire .

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Acknowledgements

I've been warned that the acknowledgements section is the hardest and most daunting part of completing a dissertation. As I sit here attempting to put into words the gratitude I feel for every individual that played a part in my journey, I am overwhelmed by how lucky I am to have the best support system. Thank you to my dissertation committee, Dr. Greer, Dr. Dudek, Dr. Fienup, Dr. Basch, and Dr. Gautreaux, for your continuous guidance and feedback on my research; it has meant the world.

Dr. Greer, thank you for always believing in me especially on days when I didn't believe in myself. I appreciate your encouraging words and your constant reminder to enjoy this journey. I am beyond thankful for your mentorship and support but above all, I'm incredibly thankful for the opportunity to learn from you. Without you, this study would not be possible. Your love for education, research, and learning is inspiring and I hope to one day impact lives the way you do!

Dr. Dudek, I repeated the words "you are the expert in the room" every time I had to present my study. I can't thank you enough for your words, insight, and edits. Dr. Delgado and Dr. Fienup, you both have shaped me into the teacher and researcher I am today. Thank you both for all the learn units and for sharing your invaluable wealth of knowledge with me. Dr. Jahromi, thank you for being part of the early days of my study and for encouraging me to ask all kinds of research questions.

Dr. Weber, I am so thankful to have you in my life. Thank you for always listening to my anxious thoughts, for always helping me problem solve, and for your unwavering support. You are a great female role model and a constant reminder of the great things that come when we put students first. I have so much to learn from you and I truly look forward to it!

To my mentors Kate, Katherine, and Ellie: *thank you* is an understatement. Kate, because of you, I got the best introduction to the science of teaching that made me fall in love with the classroom even more. Thank you for being more than just a mentor to me these past years and for having so much confidence that this day would come. I love you more than you know! Katherine, thank you for all the great memories in room 13 and for teaching me how to persevere through tough classroom moments. Ellie, you were right! Kindergarten is the best grade to teach. Thank you for all the learn units and for making me a stronger individual. Our year together taught me how to run CABAS-K and how achieve my goals no matter what.

To my first mentees, Sara, Genevieve, Ruby, and Rachel: thank you for your patience and hard work during my first year as lead teacher. Han and Ellen, thank you for you everything you did to help our students learn during the darkest days of the pandemic. I especially thank you for helping me finish my first study: all 147 probes would not be possible if it weren't for your willingness to help on all fronts. Rebecca, thank you for being the best mentee I could have asked for my third year. I appreciate your flexibility and willingness to learn; thank you for caring for our students as much as I do. I know I am leaving CABAS-K in great hands!

Everyone who works at Hillcrest knows we are a family. I have come to love this family more than words can describe. My dearest Hillcrest family, thank you for making Hillcrest my second home. To my school mom, Carol, thank you for all the hugs, words of encouragement, and chocolate throughout the years. I don't know what I am going to do without seeing you every day, but I know that you will forever be in my life. Ingrid, you are the best teacher mentor in the world. Your love for teaching and passion for social justice inspires me to be the best educator I can be. Thank you for always welcoming me into your classroom and for your enthusiasm to offer advice, a prayer, a listening ear, or help. You played such a huge role in my life these past couple of years and know our friendship will last a lifetime. Maria and Lucy, thank you for welcoming me into the K team with open arms and for your support through my years of teaching. I want you all to know I look up to you in many ways and that I will always hold onto everything you've taught me.

Greg, thank you for the opportunity to do what I love the most: teach kindergarten. Your support and feedback have shaped me into the educator I am today. Lisa, thank you for your leadership and for all of your acts of kindness. You both have made Hillcrest one of my favorite places to be. Dorelly and Otilia, your faith in God is breathtaking. Thank you both for always checking in on me and asking how I am doing, especially this year. You both have reminded me that God has a plan for me and that I am extremely blessed no matter the circumstance.

To my CABAS family at Hillcrest: there are no words to express how blessed I feel to be surrounded and supported by such talented, caring, intelligent, and powerful women. Lauren and Francis, I missed you every day this school year. Your classrooms were always a safe place for me to be just me. I appreciate your friendship and for always lending out a helping hand both personally and professionally. Ji, I've told you this a million times, but I am thankful every day to have you as my best friend. Your love and support throughout the years mean more to me than words can describe. Tanya, thank you for loving me and supporting me unconditionally. You truly have a heart of gold. You all made the past three years less daunting and have taught me how to go above and beyond for our students.

Kevin, you were there since the moment I couldn't decide on whether to peruse the ABA program at Columbia. Thank you for encouraging me to do so because the past five years have changed my life for the better. Thank you for loving me the best you can and for all you did

throughout this five-year journey. I know no matter what happens, you will always hold a special place in my heart.

I want to thank my incredible family for their constant support throughout these last five years and it is only right that I do so in Spanish. Mamá y papá, gracias por los innumerables sacrificios que han hecho para que todo esto sea posible. Mamá, gracias por darme un poco más de amor en los días en que me sentía abrumada, cansada y estresada. Gracias por todo lo que hiciste para que la escuela pudiera ser mi único enfoque. Papá, gracias por enseñarme que cualquier meta que tengo la puedo lograr con trabajo duro. Aprecio todas las veces que me hiciste mirar hacia atrás y ver todo lo que he logrado y que siempre habrá una luz al final del túnel. Realmente tengo los mejores padres del mundo y espero haberlos hecho sentir orgullosos de mi. Maty y Fernando, ambos han puesto el listón muy alto de la mejor manera posible. Ambos fueron los primeros de nuestra familia en obtener un título universitario, y eso me permitió hacerlo también. Sé que no les digo esto lo suficiente, pero sin su motivación para tener éxito, no estaría aquí hoy. Gracias por ser la mejor hermana y hermano que podría pedir y gracias por recordarme continuamente que me lo tome con un poco de take it easy. Manny, Alicia y Nick, gracias por ser los mejores amigos que necesitaré en toda mi vida. Tio Fermin, Tia Martha, Tia Chabelita, y Tia Rocio, gracias por ser los mejores tíos y tías. Ahora que soy tía, mi única esperanza es apoyar a mi sobrina y sobrino con amor incondicional como todos ustedes lo han hecho por mí.

Lastly, to all the children that I've been fortunate enough to call my students: thank you for letting me be your teacher. Teaching was always my dream and you all made it possible. Thank you for the laughs, the drawings, the letters, the hugs, and all the learning. I hope I

impacted your lives as much as you impacted mine. Remember, to always have a growth mindset and as cheesy as it sounds, you can achieve anything you set your mind and heart to.

Dedication

Para mis padres, por su sacrificio y por enseñarme que todos mis sueños pueden ser una realidad. ¡Si se pudo!

Chapter 1: Introduction and Literature Review

1.1 Reading as a Predictor for Success

The educational climate of the United States today is greatly influenced by the legislative movements that have occurred over the last two decades: the No Child Left Behind Act in 2001 followed by Every Student Succeeds Act in 2015. Both legislative movements emphasize the importance of repeated assessment throughout the school year for both reading and math to hold educators and education stakeholders accountable for student success. As a result, the educational climate heavily focuses on students' reading and math proficiency (Missall et al., 2019). Reading proficiency has achieved more significant importance in recent years as decades worth of research show how overall academic success, academic engagement, high school graduation rates, postsecondary opportunities, and economic success are all predicted by a young reader's reading proficiency (Ramirez et al., 2019).

A longitudinal study by Hernandez in 2011 was the first national study to calculate high school graduation rates based on reading levels and poverty rates for almost 4,000 students born between 1979 and 1989. The first major finding of the study is that students who are not proficient readers by third grade are four times more likely to not graduate high school on time than those who are proficient readers by third grade. Moderating variables such as poverty status further complicate this. Students who have lived in poverty and do not achieve proficient reading levels by third grade are almost three times more likely to drop out and not graduate high school than those who have never been impoverished. Students who were proficient readers in third grade and lived in poverty made up 11% of those who did not finish high school, highlighting the detrimental and cyclical effects of poverty on academic achievement. In 2019, data showed that an estimated 10.5 million children in the United States live in poverty; yet this estimate does not account for the economic disparities caused by the COVID-19 pandemic (US Census Bureau, 2019). That is nearly one in every seven children, or one in every five children of color, who face economic inequality while going to school.

Hernandez's (2011) longitudinal study empirically established the importance of proficient reading by third grade and further noted that in third grade there is an important pivot in reading education as students shift from learning to read and begin reading to learn (p. 5). The pivot that occurs at the third-grade level not only highlights the urgency to teach students how to read, but it also highlights the urgency to teach students how to comprehend literature such that they can learn from it. Hernandez's (2011) findings may serve as a reminder to educators of their utmost responsibility– to teach students, especially those who come from impoverished communities, how to read to mastery as soon as possible.

1.2 National Approach to Reading

Decades worth of research demonstrates that reading has proven to be a skill that is essential for long-term academic and economic success (Silva & Cain, 2015). Yet, in 2019, the National Assessment of Education Progress demonstrated that only 35% of 4th grade students and 34% of 8th grade students are at or above grade level in reading. More than half of the United States' 4th and 8th graders are performing below grade level in reading. Present reading proficiency levels coupled with recent poverty rates make effective reading instruction more necessary than ever. The same was true many years ago in 1997; the United States Congress appointed a panel to determine the standards of instructional practice in reading education nationwide (Shanahan et al., 2003). In 2000, the National Reading Panel (NRP) published its meta-analysis in which it concluded that high-quality reading instruction included five critical components: (1) phonemic awareness, (2) phonics, (3) fluency, (4) vocabulary, and (5) text comprehension.

The first component of high-quality reading instruction is phonemic awareness, which is the understanding that component sounds (i.e., phonemes) make up spoken words. Phonemic awareness coincides with the next component, phonics, as phonics instruction teaches the correspondence between phonemes and graphemes and incorporates segmenting and blending of phonemes (i.e., textual responding). The NRP's analysis of these two components found that the best approach to teaching phonemic awareness to children is to do so explicitly and systematically (NRP, 2000).

High-quality reading instruction also incorporates fluency instruction, which aims to teach students how to read texts quickly, accurately, and expressively (Kim, 2015). Previous studies show that cognitive constraints, such as reading with accuracy, are removed in students who read fluently, allowing them to use their working memory and attention to engage in higher-order thinking that results in meaning construction, or reading comprehension (Kim, 2015). Related to reading fluency is the reader's capacity to identify and understand words related to their reading; in other words, students' vocabulary repertoires directly influence reading achievement (Paul & Wang, 2012). Research has shown that vocabulary repertoires significantly correlate with student textual responding (i.e., decoding) performance and reading comprehension performance (Ouelette, 2006). Phonemic awareness, phonics, fluency, and vocabulary are necessary to facilitate reading comprehension, the final critical component of high-quality reading instruction. The NRP concluded that effective reading comprehension instruction teaches students the necessary strategies to derive meaning from text. Common strategies found to facilitate reading comprehension include various approaches to asking and answering questions about a text, text monitoring, graphic organizers, and methods to effectively summarize texts (NRP, 2000).

The panel's analysis on reading instruction has guided literacy programs on which domains to incorporate; however national proficiency levels in reading make it clear that educators are still struggling with *how* to effectively teach these domains. Literature pertaining to the lack of reading proficiency in students reveals the various approaches researchers have used to address this issue. Some researchers have dedicated their work to address the shortcomings of reading pedagogy, while others have opted to identify early predictors of reading achievement for primary school-aged children (Adolf et al., 2010). A myriad of variables including environmental and demographic factors, oral language, visual perception, attention, and nonverbal intelligence are known to contribute to a student's reading achievement (Adolf et al., 2010), thus the implementation of high-quality instruction in reading must go beyond the panel's basic recommendations. This is especially true as currently, educators must face their responsibility to mitigate the learning loss brought forth by school closures due to the COVID-19 pandemic (Furlong et al., 2021). School closures during the pandemic affected a global estimate of 1.6 billion students, and it is estimated that an additional 10.75 million elementary-aged students are now off track in meeting grade-level standards (McCoy et al., 2021).

1.3 Verbal Behavior Approach to Education

Though the NRP proposed effective practices to teach reading, there is still a clear need for evidence-based instruction and an effective sequence for reading pedagogy. A verbal behavior developmental approach to learning can be beneficial since education and development are undoubtedly intertwined (Greer & Keohane, 2005; Greer & Speckman, 2009; Greer & Ross, 2008; Greer et al., 2017). Verbal behavior is behavior whose reinforcement was mediated by another person in one's environment, thus it encompasses both the structure and function of human language (Greer & Ross, 2008). Verbal behavior analysis research focuses on developing functional verbal repertoires based on B.F. Skinner's *Verbal Behavior* (1957). In his work, Skinner (1957) identified seven verbal operants: (1) mand, (2) tact, (3) intraverbal, (4) echoic, (5) textual response, (6) transcription, and 7) autoclitic, all of which are verbal operants that are reinforced through the mediation of the listener. Identifying these elementary verbal operants corroborates with the perspective that verbal behavior depends on the effect (i.e., consequences) it has on the environment rather than its antecedents (Vargas, 2013; Greer, 2020). *Verbal Behavior* (Skinner, 1957) is considered pathbreaking as this work left a theoretical blueprint to analyze verbal behavior development (Pohl et al., 2017).

Skinner's identification of the elementary verbal operants also provides a framework for a verbal behavior approach to education. In education, it is important to focus on the development of verbal operants because language skills are indicators of school performance, which, in turn, affect overall life outcomes (Greer & Keohane, 2005). Skinner's philosophy of language development emphasizes establishing the stimulus control for learning new repertoires through the manipulation of the environment and delivering positive reinforcement for desired behaviors. A hierarchal trajectory of child development known as the Verbal Behavior Developmental Theory (VBDT; Greer & Keohane, 2005) was established based on this philosophy.

Empirical studies demonstrate how children progress through the hierarchy of verbal developmental stages as they progress from (1) preverbal, (2) listener, (3) speaker, (4) speaker-as-own-listener, and the extension of verbal behavior to print where the following stages are extensions of the aforementioned cusps: (5) reader, (6) writer, and (7) writer as own reader (i.e., self-editor; Greer et al. 2017). The hierarchical stages of verbal development describe a behavioral metamorphosis that is comparable to the metamorphosis process of a butterfly, since the establishment of each stage of verbal development results in a radical and powerful transformation that enables further verbal development (Greer et al., 2017). Each stage of verbal behavior development encompasses verbal cusps, which are defined as changes in behavior and stimulus control that allow individuals to learn things that they could not previously learn without the establishment of such behavior change (Rosales-Ruiz & Baer, 1997). In other words, verbal behavior cusps facilitate the emergence of learned motivating conditions and new antecedent stimulus control for verbal behavior (Greer et al., 2017).

The establishment of verbal developmental cusps accelerates rates of learning, makes new ways of learning possible, and has the potential to establish social learning milestones. In the preverbal stage of verbal development voices are conditioned as reinforcers in utero as a result of being paired with primary reinforcers such as food. Once born, faces and other environmental stimuli become conditioned as reinforcers through pairings via the environment; however, at this preverbal stage of verbal development, children are dependent on others and cannot contact the verbal community on their own. The establishment of cusps at the preverbal stage allows for the development of the listener and speaker repertoires. The development of the listener repertoire results in basic listener literacy where children can perform verbally governed behaviors but are still dependent on others to fully interact with the environment whereas, the development of the speaker repertoire allows children to fully interact with the environment through the mediation of a listener; it is at this stage that children can take part in speaker-listener exchanges (i.e., sequelics and conversational units) occurring between people (Greer & Ross, 2008). The establishment of the listener and speaker repertoires make it possible for children to develop the speaker-as-own-listener stage of verbal development. In this stage, children can function as their own listener to their speaker behavior and engage in self-talk, which describes bidirectional listener and speaker operants occurring within the skin (Greer & Keohane, 2005; Greer & Speckman, 2009; Greer & Ross, 2008; Greer et al., 2017). The speaker-as-own-listener stage of verbal development is considered fully established with the emergence of Incidental Bidirectional Naming (Inc-BiN), a higher-order behavioral relation where incidental language acquisition occurs. Inc-BiN will be discussed further; however, it is important to note that the establishment of Inc-BiN is considered to exemplify the process of complete verbal behavior metamorphosis (Greet et al., 2017).

In a similar fashion, the development of the reader and writer cusps is made possible by such verbal behavior cusps and capabilities discussed. Skinner (1957) also considered reading and writing as verbal behavior and argued that reading and writing are an extension of the listener and speaker repertoires, where reading is an extension of listener behavior and writing is an extension of speaker behavior. As such, when children are learning to read and write they require the mediation of a listener. For example, as a student is initially learning to read and is reading aloud the reinforcement for reading accurately and corrections for reading inaccurately are provided by a listener in their environment. As students become more proficient readers, the rotation of speaker responses (i.e., textual responses) and listener responses come under the stimulus control of print such that they must rely on their speaker-as-own listener repertoire to comprehend what is being read (Greer & Keohane, 2005). Without the listener and speaker repertoires as a foundation, reading and writing repertoires become nearly impossible to teach.

As described, the development of verbal behavior cusps and capabilities make learning possible. With VBDT as a framework, research has resulted in the identification of cusps and capabilities that develop as children progress through the verbal behavior hierarchy, including the necessary cusps and capabilities required to be a proficient reader.

1.4 Reading Studies on Cusps and Capabilities

1.4.1 *Learning to Read*

Conditioned Reinforcement for Books. Skinner (1957) described how adults continuously read all of the print in their environment, from advertisements to household goods labels; he further explained that print selects adults' reader behavior because it has become a conditioned reinforcer. Verbal behavior development research empirically demonstrates how critical verbal developmental cusps are in establishing the stimulus control for reading success. Research has shown that the first necessary cusp needed to begin to learn how to read is conditioned reinforcement for two-dimensional stimuli such as pictures and print. Pereira-Delgado et al. (2009) used a stimulus-stimulus pairing procedure (Sundberg et al., 1996) to condition two-dimensional stimuli for observing responses and found that the onset of conditioned reinforcement for two-dimensional stimuli increased participants' learning rate for matching responses. Greer and Han (2015) used the stimulus-stimulus pairing procedure to condition looking at two-dimensional print and found the establishment of print as a conditioned reinforcer resulted in the emergence of participants' match-to-sample repertoires for observing print stimuli. Furthermore, the emergence of conditioned reinforcement for print resulted in conditioned reinforcement for books, the subsequent necessary cusp to learning to read. Conditioning two-dimensional stimuli is a prerequisite to establish conditioned reinforcement for books (Greer & Keohane, 2005; Greer & Speckman, 2009; Greer & Ross, 2008; Greer et al., 2017; Pereira-Delgado et al., 2009). This is analogous to Skinner's (1957) example of conditioned reinforcement for print in adults: once students have conditioned reinforcement for two-dimensional stimuli, pictures and print found in books select the students' observing behaviors.

Tsai and Greer (2006) further investigated the effects of conditioned reinforcement for book stimuli (e.g., print and pictures) on students' rate of acquisition of textual responses in English. Participants were Chinese preschool students whose first language was Mandarin and who preferred to play with toys over looking at books during free time. To condition books as a reinforcer, a stimulus-stimulus pairing procedure was used. Results replicated previous literature that found the stimulus-stimulus pairing procedure to be effective in conditioning new reinforcers and that the onset of conditioned reinforcement for books accelerated participants' rate of acquisition for textual responses. After the intervention, all participants acquired new textual responses at a faster rate when compared to their learning rate prior to establishing conditioned reinforcement for books. Buttigieg and Greer (under review, 2022) extended these results by using several pairing procedures to condition books as a reinforcer. Results from this study provided additional evidence to confirm the functional relation between conditioned reinforcement for books and an accelerated rate of acquisition of textual responses.

In an unpublished dissertation, Chang (2021) conditioned books as a reinforcer using a vicarious reinforcement intervention. Participants included preschoolers with and without disabilities who did not demonstrate conditioned reinforcement for books as evidenced by their duration for observing book stimuli. The vicarious reinforcement procedure included reinforcing a peer-confederate for reading books in the presence of a target participant. During intervention, the target participant had access to other table-top activities such as puzzles but did not have access to books. Results demonstrated the establishment of books as a conditioned reinforcer, which resulted in an accelerated learning rate for sight words and an increased duration for observing print. In a follow-up study Chang (2021) isolated the vicarious reinforcement component and found that the effect was a function of the denial component of the intervention to condition books for an additional four preschoolers with disabilities and not the vicarious reinforcement. In this second study, Chang (2021) further investigated whether the number of stimuli participants recalled from books increased when the reinforcement value of books increased and whether the intervention would occasion additional observational learning repertoires. During intervention, participants observed a peer confederate receive a book as reinforcement for completing steps for a larger task, while they did not receive any feedback. The intervention procedure functioned as an establishing operation to increase the value of books as all participants subsequently observed book stimuli for a duration of at least 48, 5 s whole intervals (i.e., 240 s), which indicated the establishment of conditioned reinforcement for books. Consistent with previous findings, the establishment of books as conditioned reinforcers resulted in an accelerated learning rate for sight words (Nuzzolo-Gomez et al., 2002; Greer & Singer-Dudek, 2008; Singer-Dudek et al., 2011; Tsai & Greer, 2006; Buttigieg & Greer, under review, 2022). The establishment of books as conditioned reinforcers also functioned to increase the number of textual stimuli participants could recall from observing books, however a greater effect was observed for participants with more advanced reader repertoires. Observational learning for new operants was also established for most participants following the intervention, suggesting that the intervention functioned to establish the stimulus control to learn from observation. These studies on conditioned reinforcement for books established the importance of teaching students to select books over competing stimuli in their environment, such as toys, to learn how to read at an accelerated rate and facilitate the emergence of higher-order cusps such as observational learning.

Component to Composite Textual Responding. The onset of conditioned reinforcement for book stimuli indicates that a child is ready to learn phoneme-grapheme correspondences: the correspondence between seeing a printed letter and vocally emitting the phoneme. Learning phoneme-grapheme correspondences is a prerequisite for blending which involves the emission of component phonemes to form a composite word. Typically, blending instruction involves CVC (consonant-vowel-consonant) or CCVC (consonant-consonant-vowel-consonant) patterns such that a students' first textual responses are for transparent words (i.e., words that have one-to-one match between component graphemes and phonemes).

Prior VBDT research has focused on identifying effective teaching procedures for phoneme blending, spelling, and vocal blending. In an unpublished dissertation, Lyons (2014) investigated the effects of a computer-based auditory match-to-sample program on textual responding, vocal phoneme blending, spelling, and the rate of acquiring new textual responses. Participants for Experiment 1 included nine kindergarten and preschool students who could textually respond to components of a word (i.e., phonemes) but could not blend them to textually respond to the composite word. During the intervention, participants received match-to-sample instruction where each intervention trial consisted of three auditory buttons. When pressed, the buttons played a recording of a composite word (i.e., *mid*), matching component phonemes of the word (i.e., */m/-/i/-/d/)*, and component phonemes for a non-exemplar word (i.e., */p/-/o/-/m/)*. Participants were required to match the composite word to the corresponding component phonemes or vice versa. Lyons' (2014) study highlights the important role students' speaker-as-own-listener repertoires play in reading instruction as it showed that students must learn to listen to their own production of phonemes to produce the composite word as a speaker.

In an unpublished dissertation, Cameron (2018) measured the effects of behavioral momentum for blending instruction on textual responses, vocal phoneme blending, spelling responses, and conditioned reinforcement for print for students who demonstrated blending difficulties during typical reading instruction. Similar to Lyons' (2014) study, Cameron's (2018) study supported the idea that reading involves the establishment of speaker-as-own listener behavior. During the intervention, participants were taught how to emit component phonemes for composite word responses. Results showed that participants who did not emit component phonemes prior to intervention emitted more correct textual responses after learning to emit the component phonemes. Further, participants who did emit the component phonemes, but did not emit the composite word prior to intervention, emitted more correct textual responses without emitting the component phonemes after intervention. The findings confirm that the speaker-as-own-listener repertoire is necessary in the development of reader behavior.

Lyons (2014) and Cameron (2018) established effective methodologies that involve explicit blending and textual responding instruction with the focus being blending component phonemes into the composite words without investigating the effects of segmenting composite words into component phonemes. In an unpublished dissertation, Mellon (2019) addressed this as her study sought to investigate the effects of a vocal phoneme segmentation intervention on textual responding, spelling, and vocal phoneme blending for students who did not acquire those response topographies after receiving explicit phonics and blending instruction using research-based instructional methodologies. Participants were taught how to vocally segment five composite words into their component phonemes. Results demonstrated an increase in correct textual responses, dictated written spelling responses, novel vocal phoneme segmenting responses, and vocal phoneme blending responses as a function of the intervention. Results further showed that a transformation of stimulus function across textually responding, spelling, and vocal phoneme blending for all participants emerged following intervention.

Teaching the Function of Reading. Once students have acquired the stimulus control for accurate textual responses, the subsequent repertoire students must learn is how to read such that it governs their behavior. In other words, students must learn the function of reading. In an unpublished dissertation, Mackey (2017) developed a reader immersion protocol that targeted technical reading comprehension. Participants in the study read fluently, however their behaviors were not yet governed by print, meaning, participants could read instructions but could not follow what the instructions said. During intervention, the dependent variables were “read and build” and “read and draw,” which required the participants to emit accurate textual responses to printed text to either build or draw. The independent variable, reader immersion, established a “need to read” since participants were required to read printed text to complete their assigned task. Results demonstrate that the reader immersion protocol established the need to read, which in turn improved participants’ reading comprehension that resulted in print governing their behavior.

1.4.2 *Reading to Learn*

Conditioned Reinforcement for Content. Once students have learned to read (i.e., the structural components of reading), they must also learn how to “love to read” in order to comprehend texts and sustain interest; in other words, students must acquire conditioned reinforcement for content (Gentilini & Greer, 2020). In an unpublished dissertation, Cumiskey-Moore (2017) tested the effects of conditioned reinforcement for reading content for third grade students on reading achievement using a collaborative shared reading procedure with peers that established conditioned reinforcement for reading content. Results showed that conditioned reinforcement for reading was significantly correlated with reading assessment outcomes.

These results are further supported by literature that demonstrates the effects of conditioned reinforcement for reading on second grade students' reading comprehension and vocabulary repertoire (Gentilini & Greer, 2020, 2021). Gentilini and Greer (2020) designed instructional consequences to condition content such that the text selects out the readers' attention, which enhances the reinforcement value of reading. The reinforcement value of reading was defined as the moment-to-moment selection of the reader's attention to text; the degree to which the text maintained the reader's attention indicated the reinforcement value of the text's content (Gentilini & Greer, 2020). Additionally, Gentilini and Greer (2020) investigated which reading achievement outcomes were associated with conditioned reinforcement for content among second grade students and found that participants' reinforcement value for content was significantly correlated with measures of reading comprehension and vocabulary.

Gentilini and Greer (2020) further investigated whether the establishment of conditioned reinforcement for content improved students' reading comprehension and vocabulary. A collaborative shared reading procedure with a teacher was used to condition content for second grade students who did not demonstrate conditioned reinforcement for content. Results confirmed the functional relation between conditioned reinforcement for content and reading comprehension and vocabulary as the establishment of conditioned reinforcement for content resulted in grade-level increases of 0.1 and 2.2 grades for all participants. Furthermore, Gentilini and Greer (2021) compared the effects of the collaborative shared reading procedure with a teacher with a collaborative shared reading procedure with a peer on reading achievement. In this subsequent study, participants were second grade students who did not demonstrate conditioned reinforcement for content. Though all participants demonstrated grade-level increases on measures of reading comprehension and vocabulary following intervention, participants in the teacher condition demonstrated higher significant gains in reading achievement than students in the peer condition. These three studies highlight how conditioned reinforcement for reading content, a verbal behavioral cusp, is effective for promoting high-order reader repertories such as reading comprehension and vocabulary.

Results were extended by Bly and Greer (under review), who used a slightly modified collaborative independent reading intervention to establish conditioned reinforcement for reading content. Results from this study also demonstrate that conditioned reinforcement for reading was significantly correlated with reading comprehension, literary comprehension, informational comprehension, and vocabulary. Most importantly, results from Bly and Greer (under review) were consistent with the three Gentilini and Greer studies (2020, 2021) which concluded that the conditioned reinforcement for reading using the peer or teacher collaboration functioned as a conditioned reinforcer that acted to condition reading content that resulted in grade-level increases in measures of reading comprehension and vocabulary.

Reading Comprehension. Texts that are read must select the reader’s behavior such that the content of the text functions as an establishing operation for complex reader-as-own-listener behavior (i.e., reading comprehension; Baldonado, 2021). Verbal behavior development research on reading comprehension demonstrates how the reader-as-own-listener repertoire mirrors the speaker-as-own listener repertoire, which is necessary to learn from printed text. Before discussing literature pertaining to the reader-as-own listener repertoire, it is important to note that reading comprehension is of national concern. According to Catts and Kamhi (2012), a considerable amount of federal and state funding has been directed towards research on reading comprehension to increase national reading proficiency with no significant progress. The authors attribute this failure to the overall misconception of what reading comprehension is: reading comprehension is multidimensional, but often treated as a single entity (Catts & Kamhi, 2012).

Failure to treat reading comprehension as multidimensional may also be why most studies on reading comprehension are convoluted, as many researchers define reading comprehension differently. For example, *RAND Corporation Ready Study Group* (Snow, 2002) defined reading comprehension as a combination of the reader, the text, and the activity or purpose of reading. Others have theorized that reading comprehension is a coherent memory-based representation of the text (Kintsch, 1998). Nonetheless, results from reading comprehension studies reveal how critical reading comprehension is on future reading achievement. In addition to poor overall reading success, children with poor reading comprehension demonstrate poor recall of literal information from the text and poor inference-making skills (Silva & Cain, 2015), deficits in oral language (Catts et al., 2006), weak working memories (Pimperton & Nation, 2014), and difficulties using cognitive and metacognitive strategies (Paul & Wang, 2012). Furthermore, children with reading comprehension difficulties are likely to experience prolonged effects ranging from difficulties with employment, social functioning, and daily living (Snow, 2002).

The VBDT framework can address the different approaches in research related to reading comprehension. As previously mentioned, reading is an extension of the listener repertoire as readers must act as their own listener to the textual responses, they emit to facilitate comprehension. It is especially true since it is known that the degree to which a speaker can mediate his own speaker behavior is dependent on the degree to which the speaker listens to his own speaker behavior (Greer & Speckman, 2009). According to Skinner (1974), a person demonstrates basic listening comprehension if he or she can echo what was said to them and demonstrates complex comprehension if he or she responds appropriately to the speaker. Skinner described reading as an extension of listening because readers respond to stimuli like listeners do as they read. When one engages in reading, one responds to the visual stimuli (i.e., print) and to the auditory stimuli that is evoked by the visual stimuli, therefore, viewing reading as an extension of listening, one demonstrates basic reading comprehension if he or she can repeat what was read and complex comprehension if he or she can respond appropriately to the text (O'Donohoe & Ferguson, 2001). According to VBDT, a reader demonstrates reading comprehension when his or her reader behavior is under the stimulus control of the text such that it evokes complex reader-as-own-listener behavior.

Self-Listening. For the speaker-as-own listener repertoire, and by virtue, the reader-as-own listener repertoire to emerge, self-listening is required. In an unpublished dissertation, Alsharif (2019) described the role of self-listening, which she defined as the correspondence between hearing one's own voice and doing, as it pertains to other verbal behavior repertoires. Alsharif investigated whether there was a difference in performance behaviors when reading aloud verses when listening to one's own voice for students in second, third, and fifth grade. Alsharif further investigated whether self-listening can be established through instruction. Alsharif used two procedures to establish self-listening for participants: the first was listener instruction only where participants were taught how to listen to their own vocal directions to complete a 20-step task and the second procedure rotated listening and reading directions to complete a 20-step task. Both procedures were effective in establishing self-listening; however, Alsharif (2018) noted that the listener intervention resulted in less variability across participants. Overall results across two experiments demonstrated variable differences in performance across self-listening and reading aloud conditions, which implied that self-listening may be a separate repertoire involved in other speaker-as-own listener repertoires. The effects of self-listening on educational outcomes requires additional research, however, the identification of self-listening provides evidence that further supports listening to one's own voice is necessary for proficient comprehension in the speaker-as-own listener and reader-as-own listener repertoires.

Reader-as-own-Listener Repertoire. The reader-as-own listener repertoire is crucial for proficient reading comprehension as readers must listen to themselves read to comprehend. In an unpublished dissertation, Hill-Powell (2015) found that readers who are fluent in a silent reading condition and a reading aloud condition consistently demonstrated criterion level for reading comprehension. These results indicated that silent readers were more efficient than those who were not, which speaks to the importance of establishing students' reader-as-own-listener repertoires. In a subsequent experiment, Hill-Powell (2015) implemented a treatment package that taught participants how to read silently and measured its effects on reading comprehension for students who read fluently but did not demonstrate grade-level comprehension. During intervention, participants were taught to read silently and listen to audio recordings of texts followed by answering reading comprehension questions after each session. Results demonstrate that the intervention procedure effectively taught participants how to read silently with comprehension. These findings demonstrated that silent reading with comprehension is an essential component of acquiring a fluent reading repertoire such that students can read to learn new content. Though the importance of the reader-as-own-listener repertoire in reading comprehension is known, additional research is needed to further identify all the behaviors required for proficient reading comprehension. Though important, silent reading is only part of the reader-as-own listener repertoire, meaning that other cusps are necessary to sustain proficient reader behaviors.

1.5 Incidental Language Acquisition and Reading

Without the presence of the listener, speaker, and listener-as-own speaker repertoires, the reader repertoire becomes increasingly difficult to establish. The listener and speaker repertoires are initially independent of one another and must be joined by the establishment of incidental bidirectional naming (Inc-BiN). As such, the presence of Inc-BiN indicates that the verbal behavior metamorphosis previously mentioned is complete such that one can acquire incidental language as both a listener and a speaker (Greer et al., 2017). Inc-BiN is a momentous verbal behavior capability that allows children to contact their environment in ways not possible before, resulting in an explosion of language. Incidental language acquisition, therefore, must play a crucial role in the reader repertoire.

Inc-BiN, based on Naming Theory proposed by Horne and Lowe (1996) is one of three major theories that describe the role of derived relational responding on incidental language acquisition. Stimulus Equivalence (Sidman & Tailby, 1982) and Relational Frame Theory (Hayes et al., 2001) also provide an explanation for rapid incidental language acquisition. These three theories highlight the importance of derived relational responding as related to listener and speaker vocabularies, which directly relate to a reader’s ability to derive meaning from the text read to demonstrate reading comprehension. Each will be discussed subsequently as it relates to the reader repertoire.

1.5.1 *Incidental Bidirectional Naming (Inc-BiN)*

Horne and Lowe (1996). Horne and Lowe (1996) proposed that Naming as the most basic verbal unit that functions as a higher-order bidirectional relation that joins listener and speaker behavior. Naming theory further explains that incidental acquisition of language is the direct result of the joining of listener and speaker repertoires, which has led researchers to argue that the listener and speaker repertoires are initially independent of one another (Greer & Keohane, 2005). When the listener and speaker repertoires acquire joint stimulus control via Inc-BiN, it allows children to hear, observe, and/or experience the name of something in their environment and without additional instruction; it allows them to respond to the stimulus as a listener and a speaker (Greer & Speckman, 2009). Prior to the establishment of Inc-BiN, children cannot access incidental learning in this way from their environment; therefore, naming is a verbal capability that allows children to acquire language through experience that includes observation and other forms of indirect instruction as both a listener and speaker such that novel bidirectional relations emerge (Miguel, 2016; Morgan et al., 2020).

Horne and Lowe (1996) argued that Inc-BiN emerges around the age of three, however recent advances in the behavior analytic research have demonstrated that Inc-BiN can be established with interventions in children as young as two years old (Friedman, 2020; Gilic & Greer, 2011). Given that Inc-BiN signals the joining of the listener and speaker repertoires that are initially independent, empirical research on Inc-BiN demonstrates how the joining of the listener and speaker can be mapped into four distinct components (Frank, 2018; Kleinert, 2018; Kleinert et al., submitted; Morgan et al., 2020; Friedman, 2020; Greer & Speckman, 2009; Greer & Du, 2015; Greer et al., 2017; Greer & Longano, 2010; Miguel, 2016).

The first component is No Incidental Naming (NiN), which indicates that zero untaught listener and speaker responses have emerged incidentally. At this stage, children are not learning language incidentally from their environment therefore, they must be explicitly taught all listener and speaker responses. The presence of NiN typically indicates children are missing prior listener and speaker cusps that must be established to facilitate the emergence of Inc-BiN (Greer & Ross, 2008). The next component is Pre-Unidirectional Naming (Pre-UniN), which indicates that a few untaught listener and speaker responses emerge incidentally from naming experiences in the environment, but not sufficient to consistently demonstrate incidental learning (i.e., not 80% criterion). Pre-UniN typically indicates that children require additional multiple exemplar experiences such that Unidirectional Naming (UniN) emerges, the next component of Inc-BiN. The presence of UniN is marked by students' ability to learn listener responses (e.g., selection responses) incidentally following a naming experience provided by their environment. The presence of UniN allows children to acquire language as a listener but not as a speaker, which is critical to Inc-BiN as it is defined by its bidirectional relation. Therefore, when untaught speaker responses emerge incidentally, Inc-BiN, the last component, is present. Children with Inc-BiN can emit 80-100% accurate listener and speaker responses following a naming experience, which indicate their ability to acquire language incidentally from their environment.

Interventions to Establish Inc-BiN. Numerous studies have demonstrated that typically developing children acquire Inc-BiN without direct instruction and that its onset allows children to acquire verbal operants without direct instruction, resulting in the exponential expansion of their vocabulary (Greer et al., 2005; Fiorile & Greer, 2007; Olaff et al., 2017). Children with developmental delays often demonstrate language deficits, one of which is the absence of Inc-BiN. Numerous studies have investigated the effects of instructional tactics such as multiple exemplar instruction (MEI) across listener and speaker responses, intensive tact instruction, repeated probe procedure, and echoic training on the induction of Inc-BiN (Greer et al., 2005; Fiorile & Greer, 2007; Olaff et al., 2017; Kleinert, 2018; Kleinert et al., submitted; Chen, 2019). This body of research has reliably demonstrated that Inc-BiN can be induced through direct instruction and has great educational implications for children such as rapid language acquisition, vocabulary expansion, and an increase in learning rate for new operants.

Often, protocols to induce Inc-BiN require many learn units and can take multiple phases of interventions to reach criterion levels of BiN. Though it is crucial that Inc-BiN is established in all students, in an unpublished dissertation, Hwang-Nesbit (2021) noted that protocols and interventions typically used to establish Inc-BiN often use non-academic stimuli. Given that inducing Inc-BiN may be time consuming for teachers, inducing Inc-BiN with non-academic stimuli may take away instructional time for academic literacy content. Hwang-Nesbit (2021) designed an academic intervention based on previous structures of intervention to maximize student learning while inducing Inc-BiN. In her study, Hwang-Nesbit (2021) induced Inc-BiN in preschoolers with and without disabilities using academic curricula based on previous multiple exemplar interventions. Results demonstrated that a curriculum-based intervention not only was more effective than a repeated-probe procedure, but it also increased students' academic repertoires and established Inc-BiN. Results suggest that the induction of Inc-BiN can be incorporated into already existing teaching practices.

Familiar and Unfamiliar Inc-BiN. Recent advances have also demonstrated the difference in degrees of Inc-BiN across familiar and unfamiliar stimuli. The term "familiar stimuli" describes stimuli that share similar properties to stimuli that children typically encounter in their environment or had some sort of previous experience with. The term "unfamiliar stimuli" describes stimuli that share few, if any, properties to stimuli that children typically encountered in their environment. Research has demonstrated that children are more likely to acquire the stimulus control for Inc-BiN for familiar stimuli before they acquire the stimulus control for Inc-BiN for unfamiliar stimuli (Lo, 2016; Kleinert et al, (submitted); Cao & Greer, 2019; Mosca, 2015). These findings are supported by other literature that indicate that Inc-BiN is a verbal behavior continuum where other complex forms continue to emerge (see Cahill & Greer, 2014; Frias, 2017; Greer & Du, 2015).

Joining Print to Inc-BiN. The establishment of Inc-BiN occasions incidental listener and speaker relations to emerge. This emergence of language can be viewed as a transformation of stimulus function across listening and speaking. In an unpublished dissertation, Lee Park (2005) investigated whether the stimulus control for Inc-BiN can be transferred to print such that print joins verbal functions. In this way, reading comprehension, defined as matching symbols to untaught written words, was measured before and after the establishment of Inc-BiN. Following an MEI intervention, results demonstrated that Inc-BiN was established, and that reading comprehension emerged as a function of the establishment of Inc-BiN. Lee-Park's (2005) results demonstrate how the stimulus control for Inc-BiN can facilitate the joint stimulus control with print. In an unpublished dissertation, Helou-Care (2008) extended these findings by establishing Inc-BiN in students who demonstrated fluent textual responding responses but few accurate reading comprehension responses. Helou-Care demonstrated that the establishment of Inc-BiN resulted in increases in accurate reading comprehension responses supporting previous findings that the stimulus control for Inc-BiN can facilitate the joint stimulus control of print to verbal behavior.

Recently, the effects of Inc-BiN on reading comprehension have been further investigated in an unpublished dissertation (Baldonado, 2021). Baldonado (2021) found significant correlations between increments of Inc-BiN and reading comprehension measures, where more complex stimulus control of Inc-BiN resulted in greater reading achievement in first grade students. Furthermore, the study demonstrated how the establishment of more complex increments of Inc-BiN for unfamiliar stimuli resulted in increases in reading comprehension.

This finding suggests that more complex stimulus control for Inc-BiN facilitates the development and joining of print to the reader-as-own listener repertoire, one that is critical for reading comprehension.

Other Types of Naming. Miguel (2018) stated that the generalized BiN repertoire, which was previously described, “may be one way in which arbitrary stimuli gain symbolic properties or topographically dissimilar stimuli come to acquire the same meaning” (pg. 4). The generalized BiN repertoire occasions the formation of stimulus classes such that one can contact and understand various stimuli in the environment with the same function or meaning (Miguel, 2018). Advances in the literature on Naming has resulted in the identification of subtypes of naming that go beyond the generalized BiN repertoire, which become necessary to engage in problem-solving behavior as it requires speaker-as-own listener behavior and verbal mediation (Miguel, 2018). Similarly, reading comprehension requires reader-as-own-listener behavior, as previously mentioned, which suggests that the different types of naming may also directly influence students’ reading comprehension repertoire. Miguel (2016) first made distinctions between common bidirectional naming (C-BiN) and intraverbal bidirectional naming (I-BiN) and later argued that visual bidirectional naming (V-BiN) may be another type of naming (2018).

Common Bidirectional Naming (C-BiN). C-BiN was defined as dissimilar stimuli evoking the same speaker and listener behavior such that the operants become members of the same class (Miguel, 2016). The presence of C-BiN is a prerequisite for novel categorization tasks as it allows children to accurately problem-solve during a categorization task, whereas children who are missing the C-BIN repertoire often cannot (Miguel, 2018). Hawkins et al. (2018) further noted that Inc-BiN, as previously described, is one of the types of C-BiN. Furthermore, Miguel (2018) argued that C-BiN functions as a model to understand the processes necessary for problem solving though more advanced types of naming are necessary to engage in more complex problem solving, such as solving problems that involve chains of intraverbal responses (p. 6).

Intraverbal Bidirectional Naming (I-BiN). I-BiN describes the process by which stimuli are established to be related or equivalent in the form of intraverbal relations (Miguel, 2016). Miguel (2018) uses the example of one learning the statement "milk comes from cows", which results in an intraverbal relation between *milk* and *cow.* This intraverbal relation occasions the stimuli belonging to the same class as *cow* or *milk* to become related. I-BiN describes the process by which participants solve visual arbitrary match-to-sample (MTS) tasks after learning intraverbal relations (Miguel, 2018) suggesting that this type of naming is a prerequisite for problem-solving that goes beyond categorization tasks.

Visual Bidirectional Naming (V-BiN). In studies that assessed the role of verbal mediation on participant performance to novel MTS tasks, it was noted that participants also produced their own verbalizations about the physical features of the target stimuli (Miguel, 2018). These observations make it clear that participants were attending to the physical features of the stimuli, which suggests that participants relied on their conditioned seeing repertoire to establish relations among dissimilar stimuli, though more research on this is warranted. Nonetheless, Miguel (2018) argued that imagining (i.e., seeing objects in their presence or absence) is analogous to listener and speaker behavior: reacting to visual stimuli is analogous to listening, while seeing objects is analogous to speaking. Ultimately, Miguel (2018) labeled the process of using imagining to derive equivalence among novel stimuli as visual bidirectional naming (V-BiN). Miguel (2018) concluded that V-BiN may play a significant role in complex problem-solving behavior as demonstrated in novel MTS tasks.

1.5.2 *Stimulus Equivalence*

Stimulus equivalence (Sidman, 1994) was developed after Sidman's seminal (1971) experiment involving an intellectually disabled male student. In this experiment, Sidman trained two response topographies known as conditional discrimination responses that involved non-identity matching. In the first phase of the experiment, Sidman measured whether the student could match a dictated word to its corresponding picture in a field of eight stimuli. For example, given the dictated word "car," the subject had to select the image that depicted a car in a field of eight pictures. This was the first conditional discrimination response trained where A, the dictated word, corresponded to B, the corresponding picture (A = B). In the second phase of the experiment, Sidman measured whether the student could match dictated words to their corresponding printed word. For example, given the dictated word "car," the student selected the corresponding printed word *car* in a field of eight printed words. This was the second conditional discrimination response trained where A, the dictated word, corresponded to C, the corresponding printed word (A = C). In both phases, Sidman measured whether the subject could accurately demonstrate the trained conditional discrimination responses as well as the reciprocal: given the picture or printed word, could the subject select the corresponding dictated word? The results demonstrated that the student could demonstrate the symmetrical response. In the third phase of this experiment, Sidman measured whether the student generalized the trained relations and derived the relation among pictures and printed word without any history of reinforcement for that response topography. The results indicated that the student could match the pictures to their corresponding printed word which led Sidman to conclude that this process was responsible for how humans acquired language.

Properties of Stimulus Equivalence. Sidman (1994) claimed this phenomenon to be stimulus equivalence that describes the emergence of untaught relations after training two relations of equivalence. There are three properties of stimulus equivalence that directly correspond to mathematical properties: reflexivity, symmetry, and transitivity. Reflexivity describes the identical relation of stimuli, where stimuli A is equivalent with itself (A = A). Symmetry describes the bidirectional relation that is derived after training a conditional discrimination such that if A = B, then it can be derived that B = A. Transitivity described the derived relation that emerges after training two conditional discriminations such that if A = B and A = C, then it can be derived that B is equal to C. Sidman (1994) argued that all three properties of stimulus equivalence are required to be present to say that a subject has demonstrated stimulus equivalence.

Implications to Reading Comprehension. Sidman (1994) argued that the theory of stimulus equivalence explains where emergent relations come from. It was the first attempt to describe the emergence of language and language that was acquired without any direct instruction. The emergence of untaught relations is a direct result of reinforcement contingencies in one's history and their existence can account for symbolic relations in human language and abstraction (Sidman, 2000; Sivaraman et al., submitted). According to this theory, stimulus equivalence can be beneficial to teach and measure reading comprehension; in particular, to teach the meaning of words. This suggests that stimulus equivalence is a prerequisite for proficient reading comprehension so that readers can derive the meaning of words in text based on existing equivalent relations. Despite this educational implication, stimulus equivalence relies on stimulus-stimulus relations indicating that sameness among stimuli is required to demonstrate stimulus equivalence. Such stimulus-stimulus relations are equivocal relations that do not require the mediation of language (i.e., a listener), therefore, stimulus equivalence is not a description of verbal behavior but rather a principle of equality.

1.5.3 *Relational Frame Theory*

Properties of Relational Frames. Stimulus equivalence (Sidman, 1994) provided the framework for others to continue to research the emergence of language. Hayes and Hayes (1989) proposed the relational frame theory (RFT) as a more expansive account of language that accounts for complex human language. RFT argues that equivalence relations were due to a history of arbitrarily applicable relational responding (Sivaraman et al., submitted). Proponents of RFT argue that it is the arbitrary applicable relational responding (AARR) that is responsible for the emergence language (Hayes et al., 2001). AARR is made up of three relational frames known as mutual entailment, combinatorial entailment, and transformation of stimulus function.

Mutual entailment describes a fundamental bidirectional relation among stimuli that emerges when given a context that accounts for Sidman's property of symmetry and expands on it (Hayes et al., 2001). For example, given that Jose is older than Aida (A > B), one can derive that Aida is younger than Jose (B < A). This type of derived relation, though mutually entailed, does not demonstrate the property of symmetry because the relation among Jose and Aida is arbitrary. Therefore, though mutually entailed relations are bidirectional, they are not always symmetrical as they do not rely on sameness.

Combinatorial entailment describes the relation derived from two or more stimulus relations (Hayes et al., 2001). For example, if Jose is older than Aida, and Aida is older than Mimi (A>B and B >C), one can derive that Jose is older than Mimi (A> C) or Mimi is younger than Aida (C < B) without ever being directly taught that relation. Transformation of stimulus function occurs when a trained relation for a behavioral function is present, and another stimulus acquires the function without direct training. For example, if a student learns the trained relation that touching a hot stove is punishing (i.e., causes one to burn) and knows that a heater also produces heat, the heater may acquire the same punishing qualities as the stove. In this example, unrelated stimuli can acquire the same functions as other stimuli without direct training based on AAARs.

RFT is an account of arbitrary relations among stimuli and the emergence of untaught relations among them and comprises a popular account for verbal behavior. To summarize, RFT proponents argue that verbal behavior involves a history of reinforcement for responding with a range of contextually controlled arbitrarily applicable relations known as relational frames (Barnes-Holmes et al., 2000). Recent advancements in RFT demonstrate that cooperation skills play a critical role in the emergence of arbitrarily applicable relational responding, which can be explained by empirical evidence of listener cusps set forth by verbal behavior development theory (Greer & Ross, 2008; Sivaraman et al., submitted).

Stimulus equivalence and relational frame theory, though separate, share similar features as both are an attempt to explain emergent behavior (Sivaraman et al., submitted). For example, in relational frame theory, mutual entailment describes relations derived from a trained relation which is similar to the property of symmetry in stimulus equivalence. Furthermore, combinatorial entailment described a derived relation as a direct result of two or more stimulus relation which is similar to transivity in stimulus equivalence. Nonetheless, both theories differ in their explanation of why and how emergent behavior occurs. Stimulus equivalence argues that emergent behavior is a result of responding correctly within the relations of reflexivity, symmetry, and transivity whereas, RFT argues that emergent behavior is a result of AARR that is acquired through a history of multiple exemplars. A major difference is that stimulus equivalence requires the training of two relations whereas RFT requires the rotation of multiple exemplars in a variety of contextual cues.

Implications to Reading Comprehension. Though Baldonado (2021) demonstrated that increased stimulus control for Inc-BiN facilitates reading comprehension, she further noted that reading comprehension measures assess multiple forms of relations when responding to reading, meaning that reading comprehension is the process of deriving relations from text. For example, when students demonstrate reading comprehension in a read-do task where students textually respond to printed instructions and produce a matching picture, mutually entailed relations are observed between the printed words (A) and the visual stimuli (B) that is produced by reading and doing. Further, combinatorially entailed relations are observed between the A-B relation and other operants in their production response such as color, orientation, and word-objects relations not directly taught (Baldonado, 2021). Baldonado (2021) further explained how other measures of reading comprehension and vocabulary required the formation of combinatorially entailed relation and mutually entailed relations.

Across two studies, Baldonado (2021) demonstrated how increased stimulus control for Inc-BiN, one of the earliest relational frames (Barnes-Holmes et al., 2001), transforms the reader-as-own-listener repertoires as a function of increased mutually entailed and combinatorially entailed relations. It was observed that establishing the stimulus control for Inc-BiN set the occasion for students to derive mutually entailed and combinatorially entailed relations as evidenced by increases in reading comprehension and vocabulary during novel experiences in reading. Therefore, the role of derived relations is crucial to the process of teaching reading comprehension.

1.6 Other Verbal Behavior Repertoires and Reading Comprehension

Despite numerous studies that show relations between verbal behavior developmental cusps and reading comprehension, additional research that explores how reading comprehension relates to other verbal behavior repertoires is necessary. The prevalence of reading comprehension difficulties can be observed in literature that outlines a myriad of reading comprehension issues across students in all grade levels. The prevalent issues surrounding reading comprehension call into question the type of instructional strategies used to teach students how to derive meaning from texts. The NRP's (2000) suggestions on designing instruction around strategies such as questioning, predicting, summarizing, and clarifying have caused some researchers to argue that reading comprehension problems arise from a lack of diverse instructional strategies for reading comprehension (De Koning & Van der Schoot, 2013). Common strategies used to teach reading comprehension have resulted in little attention to strategies related to the sensory experience of reading such as visualization of the text's content (De Koning & Van der Schoot, 2013).

Previous literature on the effects of visualization on reading comprehension have demonstrated that visualizing a text's content is necessary for adequate understanding of the text (Snow, 2002). Visualization of a text shares similar issues to reading comprehension in that there are many definitions of what it is. In general, it is the process of forming non-vocal representations of objects or events that are not physically present but rather, are described via the text (De Koning & Van der Schoot, 2013). Theories that were prominent in the 1970s and 1980s, such as the Dual Coding Theory (Paivio, 1971), attempted to describe the relationship between visualization and reading comprehension, yet De Koning & Van der Schoot (2013) argue that research regarding visualization and its role in reading has gained renewed interest.

Advancements in this area of research, though limited, conclude that visual representations of the text improve reading comprehension for children at various levels of reading proficiency (see De Koning & Van der Schoot, 2013; Mercorella, 2017).

The role of visualization in reading was also discussed by Skinner (1953, 1957). Skinner acknowledged that some human behavior is private, meaning that it only occurs within one's own skin. Visualizing texts, therefore, is a private event that occurs within one's skin as a result of emitting reading behavior (i.e., textual responding). When a reader visualizes text, the reader is "seeing" stimuli that are not physically present in their environment and this visualization is only accessible to the reader. Skinner (1953) named this covert and private visualization process *conditioned seeing*.

1.6.1 *Conditioned Seeing*

Skinner (1957) defined conditioned seeing as seeing or hearing stimuli that are not present in the physical environment. Conditioned seeing is explained as a reflex that is a result of a history of conditioned stimuli, therefore, conditioned seeing follows the pattern of a conditioned reflex (p. 266; Skinner, 1953). When a person describes "seeing" or "hearing" stimuli he or she may do so when the stimulus is physically present in the environment, but also may do so in the absence of the stimuli if other stimuli that were previously paired (i.e., conditioned) are present (Skinner, 1953). For example, if a dinner bell and food were conditioned such that the presence of a dinner bell becomes a discriminative stimulus for food, a person might report "seeing" food in the presence of the dinner bell despite the absence of food in their immediate environment. Skinner (1953) described how conditioned seeing responses are directly influenced by a person's history of reinforcement but further noted that some conditioned seeing responses are operant responses rather than respondent responses.

Operant responses in relation to conditioned seeing do not rely on previous pairings of stimuli, but rather are dependent on operant reinforcement or states of deprivation (p. 272; Skinner, 1953). Skinner gives two examples of this: the first example is of a man in the state of deprivation for food who claims to "see" food in the absence of food in his physical environment. In this example, it can be observed that a state of deprivation sets the occasion for conditioned seeing. In the second example, Skinner describes a person with a well-established history of reinforcement for finding four-leaf clovers (i.e., reinforcement was delivered each time a four-leaf clover was found). Skinner (1953) argued that this history of operant reinforcement sets the occasion for the person to "see" four-leaf clovers in response to stimuli that resemble them such as stimuli on walls, textiles, or three-leaf clovers.

Dugdale (1996) used the concept of conditioned seeing to challenge Horne and Lowe's (1996) naming hypothesis as he noted that it assumed that participants cannot hear the names of stimuli unless a discriminative stimulus is provided by the participant or someone else (pg. 273). Dugdale (1996) argued that conditioned seeing, which extends to other forms of stimulus-stimulus relations beyond hearing and seeing (e.g., seeing and hearing), is a prerequisite to remembering the relations among arbitrary stimuli. For example, if a child observes a shoe in the presence of its caregiver and the caregiver provides the auditory stimulus "shoe," it is possible that the child can *hear* shoe in the absence of the caregiver in future encounters with shoe stimuli, which will allow the child to engage in operant contingencies that involve shoes without the presence of a naming repertoire (e.g., novel matching responses; Dugdale, 1996). Dugdale (1996) hypothesized that a conditioned seeing or conditioned hearing repertoire is sufficient to engage in novel behavior.

Using conditioned seeing as a framework, researchers have investigated how it affects the verbal development in children related to imaginary symbolic play (Lee et al., 2019). Lee et al. (2019) considered symbolic play with imaginary objects (e.g., pretending to drink from a cup or feeding imaginary food to a baby doll) a demonstration of conditioned seeing and argued that the acquisition of a tact response for a given stimulus may be acquired prior to or in tandem with the conditioned seeing response for that stimulus. To show this, Lee et al. (2019) taught preschoolers with autism how to symbolically play with imaginary objects (e.g., pretending to draw with an imaginary pencil and paper) and how to intraverbally respond when asked what they were doing. After this intervention, all participants emitted more instances of imaginary symbolic play in free-play settings demonstrating that conditioned seeing responses, in the form of symbolic play, can facilitate novel intraverbal responding.

Conditioned seeing responses are also thought to play significant role in novel intraverbal responding (Mellor et al., 2015; Kisamore et al., 2011). Mellor et al., (2015) argued that teaching individuals how to engage in conditioned hearing (i.e., hearing stimuli that are not physically present) may facilitate novel intraverbal behavior. Using auditory tact instruction, researchers taught participants how to tact animals or items given their sound and found that participants' intraverbals increased. Though not definitive, it is possible that the auditory tact instruction used functioned to elicit conditioned seeing responses such that novel intraverbal responding could emerge.

Results from Mellor et al., (2015) extend results found by Kisamore et al., (2011) who studied the effects of a visual imagining procedure on category intraverbal behavior in preschool children. Kisamore et al. (2011) taught four typically developing preschoolers how to emit intraverbal categorization responses using subcategory-item intraverbal training, multiple tact training, and visual imagining training. Results demonstrated that participants could emit categorical intraverbals after visual imagining training, however a vocal prompt to visualize their responses was required. These results indicate that young children can be taught how to visualize responses that are not evoked by a verbal antecedent (Kisamore et al., 2011). Results from such studies demonstrate how visualization can facilitate the emergence of novel behaviors, though more research is necessary. In recent years, Skinner's identification and explanation of conditioned seeing has been used to describe the role of visualization in reading comprehension. To understand this role, it is important to understand Skinner's view of reading comprehension.

Skinner (1957) defined one component of reading as engaging in textual behavior where there is point-to-point correspondence between the written word and the spoken word. Furthermore, Skinner emphasizes that reading comes under the stimulus control of the visual stimuli (print) through reinforcement. Therefore, using verbal behavior development as a theoretical framework, one can view reading as an operant that is the sequence of an antecedent, response, and consequence. Accurate textual responding is fundamental to reading, but while necessary, it is not sufficient for reading achievement and reading comprehension. Skinner (1957) further described that conditioned seeing occurs within one's skin while reading: if a reader is under the stimulus control of the text, meaning that the text is controlling the behavior of the reader, then the reader will "see" what is being described in the text as a function of conditioned seeing (1957). Skinner (1957) explained this phenomenon using the death of Little Nell in *The Old Curiosity Shop by Charles Dickens*: as the reader textually responds to the text, the reader also visualizes the event such that he or she has an emotional response. If conditioned seeing occurs while reading, it is then concluded that the reader has comprehended the printed words.

Skinner, therefore, defined reading comprehension as the process of engaging in conditioned seeing while under the stimulus control of print. With respect to reading, conditioned seeing responses occur based on an existing history of relations to stimuli present in the environment (i.e., stimulus-stimulus relations). As previously described, VBDT research has been critical in identifying the cusps and capabilities that students need to be lifelong learners, including those required to function as a proficient reader (Greer & Keohane, 2005). Skinner's identification of conditioned seeing has resulted in efforts to empirically map exactly how conditioned seeing relates to Inc-BiN and reading comprehension.

1.6.2 *VBDT Research on Conditioned Seeing*

In an unpublished dissertation, Shanman (2013) tested the relation between Inc-BiN and conditioned seeing and found a statistically significant correlation. Shanman (2013) hypothesized that conditioned seeing occurs after a naming experience where the experimenter pairs visual stimuli with spoken words. Participants were asked to draw each visual stimulus without its physical presence; as such, Shanman (2013) argued that participants' drawing responses were copied from participants' covert visualization of the stimuli that occurred during the time of drawing probes. Shanman (2013) concluded that conditioned seeing was the result of conditioning such visual stimuli during the naming experience. In a second experiment, Shanman (2013) found that the drawing responses were significantly correlated to participants' untrained speaker responses. Though correlated, achieving criterion level for drawing responses (i.e., conditioned seeing) did not necessarily result in the emergence of Inc-BiN but suggests that the conditioned sensory response may play a role in the acquisition of incidental word-object relations. Though significant correlations were found between participants' drawing responses and their untrained speaker responses, no significant correlation was found between participants' drawing responses and untrained listener responses. Since conditioned seeing in this study was measured by a production response, it is possible that the measurement of conditioned seeing yielded significant correlations with untrained speaker responses, another production response, and not untrained listener responses, a selection response.

In a subsequent unpublished dissertation, Mercorella (2017) tested the relationship between conditioned seeing and reading comprehension in 3rd and 4th grade students. In her first experiment, Mercorella (2017) found that participants who performed below grade-level in reading did not demonstrate Inc-BiN and had fewer accurate drawing responses. These findings corroborate Shanman's (2013) findings that suggest that conditioned seeing plays a significant role in Inc-BiN. In the second experiment, Mercorella (2017) compared reading comprehension scores across participants performing below, at, and above grade-level in reading. Mercorella (2017) further compared their reading comprehension scores across two reading conditions: with pictures and without pictures. Results showed that students reading below grade-level had significantly lower comprehension scores for texts with pictures and texts without pictures than students reading at or above grade-level. Results also showed that students reading below grade-level in reading had significantly lower comprehension scores during the condition without pictures when compared to the condition with pictures. For students performing at or above grade-level, there were no significant differences found in their reading comprehension scores when compared across the two conditions. Furthermore, participants' mean comprehension scores were significantly correlated to the number of accurate drawing responses. These results show that students performing below grade-level in reading rely on visuals in books to facilitate reading comprehension whereas students performing at or above grade-level can comprehend texts independent of visuals, which support prior literature that suggests that visualization of the text is necessary for reading comprehension.

In the last experiment, Mercorella trained participants to create visual images of texts using the Story Board (https://www.storyboardthat.com) in the correct sequence to mastery. Upon completion of the intervention, most participants showed greater reading comprehension and criterion level of conditioned seeing as measured by drawing responses.

In an unpublished dissertation, Syed (2018) further investigated the relationship between Inc-BiN and conditioned seeing. In her first experiment, Syed tested whether conditioned seeing, measured by delayed drawing responses, is a component of Inc-BiN and whether multiple exemplar instruction across listener, speaker, and drawing responses could establish the presence of Inc-BiN and delayed drawing responses. Results demonstrated that the MEI intervention resulted in increases in untaught listener and speaker responses as well as delayed drawing responses. The effects of multiple exemplar instruction across listener, speaker, and drawing responses were compared to a repeated probe control group. Participants in the repeated probe condition received multiple probes for listener, speaker, and drawing responses and Inc-BiN and criterion level of drawing responses were not achieved without the MEI intervention.

In a subsequent experiment, two participants with Inc-UniN and high accurate delayed drawing responses received a learn unit intervention that required them to draw a target unfamiliar stimulus while vocally naming it to 100% accuracy. Following the learn unit intervention, Inc-BiN was established for both participants. Syed (2018) argued that the learn unit intervention functioned to establish a history of conditioned reinforcement for unfamiliar stimuli. Particularly, the learn unit intervention paired drawing responses of unfamiliar stimuli with multiple sensory experiences. In a follow-up experiment, Syed used the same learn unit intervention with four participants without Inc-UniN. Results demonstrated the establishment of Inc-BiN and conditioned seeing for all participants following the learn unit intervention. Syed's (2018) study implied that conditioned seeing may be a component of BiN for unfamiliar stimuli since delayed drawing responses increased with the establishment of BiN. Results of this study call into question whether the establishment conditioned seeing affects Inc-BiN since it was determined that Inc-BiN affected levels of conditioned seeing.

1.6.3 Rationale for Study

Previous VBDT research outlines the importance of verbal behavior cusps and reader repertoires essential for reading achievement. Such literature also provides insight into how the behavior of reading emerges. First, literature supports that the essential stimulus control to learn to read, such as conditioned reinforcement for two-dimensional stimuli and conditioned reinforcement for books, are critical in the emergence of the reader repertoire. Instruction thereafter must establish the phoneme-grapheme correspondence and establish the transformation of stimulus function across textual responding, spelling, and vocal blending (Lyons, 2014; Cameron, 2018; Mellon, 2019). Alongside this, the "need to read" must be established to better improve explicit reading comprehension (Mackey, 2017). Beyond this, the literature outlines how students must demonstrate conditioned reinforcement for reading and conditioned reinforcement for reading content as they are necessary to the reader-as-own listener repertoire and reading comprehension (Gentilini & Greer, 2020; Bly & Greer, under review; Hill-Powell, 2015).

Results from Shanman (2013), Mercorella (2017), and Syed (2018) suggest the importance of Inc-BiN and conditioned seeing in reading comprehension in older readers. These raise the question of whether the same is true for readers in earlier grades given that proficient reading status must be achieved by third grade in order to achieve overall academic and life success (Hernandez, 2011). Results from Baldonado (2021) suggest that the onset of Inc-BiN is functionally related to the development of the reader as-own-listener repertoire in first grade students yet, what is known about the presence of conditioned seeing in students from older grades tells us little about the development of conditioned seeing in younger grades and its relation to early reading comprehension.

Mercorella's (2017) study highlighted the importance of pictures during reading and the importance of teaching students *how* to visualize the text when no visuals are present. Since prior to third grade, students are learning how to read, most beginner texts and teacher materials include multiple exemplars of corresponding pictures. This gradually changes as students progress beyond third grade and begin to read more complex texts with fewer pictures, making conditioned seeing more necessary. Therefore, it is important to determine whether conditioned seeing for students in kindergarten through second grade also results in greater reading achievement to fill the missing gap in the literature. If so, establishing conditioned seeing should be part of early reading instruction. which may result in greater and better use of beginner texts and teacher materials that include many visuals. Establishing conditioned seeing prior to third grade may mitigate the robust outcomes of poor reading proficiency in students' future.

The purpose of this study is to evaluate the role of conditioned seeing in young readers in grades kindergarten through second grade. To do so, the study determined if there is a correlation between conditioned seeing, incidental bidirectional naming, as measured by untaught listener and speaker responses, and standard reading achievement measures given during the academic school year in the Winter and Spring.

1.6.4 Research Questions for Experiment 1

The initial study and impetus for the second experiment addresses the following descriptive research questions:

1. Are there significant correlations between the stimulus control for conditioned seeing and the stimulus control for (a) untaught listener responses; (b) untaught speaker responses; and (c) overall *iReady® K-12 Adaptive Reading* diagnostic scores and its following sub-scores: (d) literature comprehension scores; (e) informational text comprehension scores; and (f) vocabulary scores?
2. Is there an association between participants' level of conditioned seeing and their performance percentile on the *iReady® K-12 Adaptive Reading* diagnostic?
3. Are there differences in (a) the stimulus control for untaught listener responses (Inc-UniN); (b) the stimulus control for untaught speaker responses (Inc-BiN); d) overall *iReady® K-12 Adaptive Reading* diagnostic scores and its following sub-scores: (d) literature comprehension scores; (e) informational text comprehension scores; and (f) vocabulary scores based on low and high stimulus control for conditioned seeing?

Chapter 2: Experiment 1

2.1 Method

2.1.1 Participants

Forty-nine 5- to 8-year-olds were recruited from the same Title 1 kindergarten through second grade public elementary school located in a suburban town found outside a major metropolitan area. Participants were selected from classrooms that used the Comprehensive Application of Behavior Analysis to Schooling (CABAS®) Accelerated Independent Learner (AIL) education model (https://www.cabasschools.org/). There were 16 kindergarten participants (*M* age = 5.84, *SD* = .30), 15 first grade participants (*M* age = 6.97, *SD* = .31) and 18 second grade participants (*M* age = 8.20, *SD* = 1.05). Of the 49 participants, 21 were female (42.9%) and 28 were male (57.1%) and 23 (46.9%) had an individualized education plan (IEP). Regarding ethnicity, 8.2% of the participants were Black, 38.8% were Hispanic and/or Latino, and 53% were White.

2.1.2 Setting and Materials

The study took place in the participants' classroom. The CABAS® AIL curricula were based on Common Core standards, state standards, and curricula provided by the school district. All instruction was delivered using Instructional Demonstration Learn Units (IDLUs) and learn units (Albers & Greer, 1991; Hranchuk, 2016). Each classroom was equipped with individual student desks, a teacher desk, and chairs.

The *iReady® K-12 Adaptive Reading* Diagnostic (Curriculum Associates LLC, 2017) is administered twice a year for kindergarten students, in the Winter and Spring, and three times a year for students in first and second grade to include the Fall. Given that there are no Fall scores for the kindergarten participants, only the Winter and Spring scores were used in this study. The reading diagnostic was administered by participants' teacher in a class-wide setting for general education students and in a small-group setting for students with testing accommodations. Each participant received headphones and took the diagnostic on a Chromebook. All participants received an unlimited amount of time to complete it.

For Inc-BiN probes and conditioned seeing probes, five sets of novel visual stimuli and names were used that were also used in previous conditioned seeing studies (see Shanman, 2013; Mercorella 2017). Table 1 displays stimuli sets used during Inc-BiN and conditioned seeing probe sessions for all participants. Each symbol was paired with a mono-syllabic name at random and presented using a Microsoft PowerPoint® slideshow. Each slideshow contained 20 slides, four slides for each symbol. All sets were counterbalanced across participants and no two sets were presented more than once. During conditioned seeing probes, participants were provided with a pencil and eraser and drawing sheet, see Appendix A.

Table 1

Sets of Stimuli for Naming Probes and Conditioned Seeing Probes

Set 1	Ξ Nuc	Φ Pid	⌘ Kaj	≈ Sir	∫ Gox
Set 2	⊑ Hap	δ Sut	Ω Bov	ϖ Dem	ϑ Mer
Set 3	π Des	≅ Vop	⏏ Jus	ζ Lak	∞ Mef
Set 4	♮ Jev	§ Zim	⌥ Tul	λ Fap	¥ Hod
Set 5	⍱ Tal	⍋ Bik	Γ San	≠ Rah	£ Pil

Note. The same stimuli were used in Shanman (2013) and Mercorella (2017) who noted that CVC words and stimuli were paired randomly.

2.1.3 Dependent Variables

There were 12 measures in this study: stimulus control for Inc-BiN as measured by 1) untaught listener responses (i.e., point-to responses) and 2) untaught speaker responses (i.e., untaught intraverbal responses); 3) stimulus control for conditioned seeing as measured by drawing responses; and reading achievement as measured by 4) overall *iReady® K-12 Adaptive Reading* diagnostic scores, 5) literature comprehension diagnostic scores, 6) informational comprehension diagnostic scores, 7) vocabulary diagnostic scores, and 8) performance percentiles for the *iReady*® reading diagnostic. For measures four through eight, both the Winter and Spring measures were used.

Stimulus Control for Inc-BiN

The stimulus control for Inc-BiN was measured using a numerical measure that indicates the stimulus control for acquiring incidental word-object relations. The stimulus control for Inc-BiN was measured by three Inc-BiN probes for each participant which consisted of counting the total number of correct untaught listener and untaught speaker responses following a brief novel naming experience for unfamiliar stimuli (see Table 1). Each probe measured 10 untaught listener responses and 10 untaught speaker responses, two for each of the five stimuli across each topography.

Untaught listener responses measured participants' stimulus control for Inc-UniN and were measured by point-to responses. A correct point-to response was defined as the participant physically pointing to the corresponding visual stimulus in an array of three exemplars upon the vocal antecedent of "Point to ___." Untaught speaker responses measured participants' stimulus control for Inc-BiN and were measured by intraverbal responses. A correct intraverbal tact was defined as the participant saying the name of the visual stimulus given any one of the following vocal antecedents: What is this? What is his/her name? What do we call this? What is this called? Who is this? The total number of correct untaught listener and untaught speaker responses across the three brief Inc-BiN probes were added to represent the overall stimulus control of Inc-BiN for unfamiliar stimuli for each participant.

Drawing Responses (i.e., Conditioned Seeing)

The stimulus control for conditioned seeing for each participant was measured by three drawing probes that were conducted immediately after each Inc-BiN probe. Drawing probes were conducted using the same procedure as Shanman (2013), Mercorella (2017), and Syed (2018). Each drawing probe was comprised of five opportunities to draw the novel stimuli that were presented during the preceding Inc-BiN probe. Drawing responses were a measure of conditioned seeing since participants were required to draw the stimuli in the absence of the auditory and visual stimuli that were paired during the naming experience. A correct drawing response was recorded if the participant drew one of the five target stimuli in any orientation (e.g., upside down, backwards, reversed) and an incorrect drawing response was recorded if the participant drew a nontarget symbol or if the participant did not emit a drawing response. The number of correct drawing responses across three conditioned seeing probes were summed together to determine the participants stimulus control for conditioned seeing. See Appendix A for examples of drawing responses.

Reading Achievement

Participants' reading achievement was measured using the Winter and Spring *iReady® K-12 Adaptive Reading* diagnostic. The following measures from both diagnostics were included: (a) overall diagnostic scores, (b) literature comprehension diagnostic scores, (c) informational comprehension diagnostic scores, (d) vocabulary diagnostic scores and (e) participant performance percentiles. The *iReady®* diagnostic provided scaled scores ranging from 100 to 800.

Overall Diagnostic Scores and Percentiles. The *iReady*® reading diagnostic is a standard based assessment designed to measure student performance in six domains: 1) phonological awareness, 2) phonics, 3) high-frequency words, 4) vocabulary, 5) literature comprehension, and 6) informational comprehension. Each domain influences the overall diagnostic score that determines whether the participant is performing above grade level, on grade level, or below grade level. Performance percentiles for each diagnostic were also used. Participants' performance percentiles were determined by comparing each participant's performance to a nationally representative sample of students in the same grade level who completed the diagnostic at the same time of the school year.

Literature Comprehension, Informational Comprehension, and Vocabulary. Literature comprehension scores reflect participants' "understanding of literary fiction texts." Skills measured in this domain include identification of story elements, retelling and summarizing, making inferences, comparing, and contrasting texts, and character analysis. Informational comprehension scores reflect participants' understanding of informational non-fiction text. Skills measured in this domain include asking and answering questions about key details, categorizing, and classifying information from the text, sequencing, main idea, and author's purpose. Vocabulary scores reflect participants' understanding of word relations in text. Skills measured in this domain include word relationships, use of academic and domain specific vocabulary, and word-learning strategies.

2.1.4 Procedures

Teachers were instructed to administer the *iReady® K-12 Adaptive Reading* Diagnostic assessment in their classroom using participants' Chromebooks and headphones. It is important to note that each teacher who participated in the study is a trained strategic scientist of teaching and collects data on students' responses to academic instruction, self-management, and classroom performance. The teachers have also performed multiple experiments as part of their graduate training in the laboratory science of teaching classrooms.

Teachers assisted students in logging onto the *iReady®* platform but each diagnostic was completed by the individual participant with no additional testing accommodations unless indicated in an IEP. Researchers collected students' *iReady® K-12 Adaptive Reading* diagnostic (Curriculum Associates LLC, 2017) scores from the respective classroom teacher as well as their percentile placement when each participant completed the diagnostic.

Incidental Bidirectional Naming Probes

Three Inc-BiN probes were conducted for all participants. Three different sets of five novel stimuli were presented across three brief naming experiences (see Table 1). During each naming experience, the five novel stimuli were presented four times each and were followed by a single probe session that measured participants' untaught listener responses (i.e., point-to responses) and untaught speaker responses (i.e., intraverbal responses) or two opportunities for each stimulus across both topographies.

Naming Experience. To begin, each participant sat across from or next to the researcher as the researcher conducted a brief naming experience to a novel set of five stimuli. The brief naming experiences were designed to provide an experientially controlled simulation of exposure to novel stimuli in naturalistic settings. During the brief naming experience, five novel stimuli were presented four times for a total of 20 trials. All the slides were organized so that each symbol was presented in a rotated manner. The researcher presented each slide individually and vocally identified each symbol and the participant was required to echo (i.e., vocally repeat with point-to-point correspondence between the teacher's model and the student's response) the name of each symbol. Following a period of at least two hours, a single probe session followed.

Untaught Listener Responses (i.e., point-to responses). The researcher used a PowerPoint® presentation with 10 slides, each containing three of the target stimuli. The researcher presented each slide and vocally instructed the participant to "Point to __" one of the target stimuli. Participants were given two opportunities to respond per stimulus for a total of 10 probe trials. The total number of correct point-to responses across three Inc-BiN probes (i.e., blocks of 10 trials) were collapsed (i.e., added together) to determine the participants' existing increments of stimulus control Inc-UniN. All responses were unconsequated.

Untaught Speaker Responses (i.e., intraverbal tact responses). The researcher used a PowerPoint® presentation with 10 slides, two slides for each of the five target stimuli. All the slides were organized so that each stimulus was presented in a rotated manner. The researcher presented the participant a slide and delivered one of the following vocal antecedents: What is this? What is his/her name? What do we call this? What is this called? Who is this? Participants were given two opportunities to respond to each stimulus for a total of 10 probe trials. The total number of correct intraverbal responses across three Inc-BiN probes were collapsed (i.e., added together) to determine the participants' existing increments of stimulus control Inc-BiN. All responses were unconsequated.

Drawing Probes (i.e., Conditioned Seeing)

Immediately following Inc-BiN naming probes, a drawing probe was administered. The participant was given a piece of paper with five blank boxes (see Appendix A) and the vocal antecedent to "Draw the symbols you just saw." The participants were given an unlimited amount of time to complete their drawing responses. The drawing probe ended when the participant communicated to the researcher that he or she did not remember any more stimuli twice or when the participant emitted five drawing responses, whichever came first. The total number of correct drawing responses across three conditioned seeing probes were collapsed (i.e., added together) to determine the participants' stimulus control for conditioned seeing. See Appendix A for examples of drawing responses.

2.1.5 Interobserver Agreement

Interobserver agreement (IOA) was collected across Inc-BiN probes and drawing probes (i.e., conditioned seeing) with a second, trained, and independent observer. IOA was calculated by dividing the number of point-to-point agreements by the sum of agreements and disagreements and multiplying by 100. For Inc-BiN probes, IOA was obtained for 41.5% of sessions with a mean agreement of 98.5% (range, 80% to 100%). For drawing responses, initial IOA was obtained for 86.4% of sessions with a mean agreement of 98.1% (range, 80% to 100%).

To ensure accurate data analysis, a second stage of IOA corrected all disagreements across drawing probes. A third, trained, and independent observer reviewed all probes with discrepancies and was asked to score the number of correct drawing responses in each. The data from this third independent observer were used to settle the disagreements between the first two data collectors and led to 100% agreement for drawing responses.

2.2 Results

2.2.1 Associations between Conditioned Seeing, Inc-BiN, and Reading Achievement

Pearson's R correlation coefficient tests were conducted to statistically analyze whether there were significant correlations between participants' stimulus control for conditioned seeing and (a) stimulus control for untaught listener responses (Inc-UniN); (b) stimulus control for untaught speaker responses (Inc-BiN); c) overall *iReady® K-12 Adaptive Reading* diagnostic scores (d) literature comprehension scores; (e) informational text comprehension scores; and (f) vocabulary scores.

Results demonstrate that there were statistically significant positive correlations between participants' stimulus control for conditioned seeing and stimulus control for Inc-UniN, r (47) = .440, p = .002, and stimulus control for Inc-BiN, r (47) = .384, p = .007, suggesting that the stimulus control for Inc-BiN and conditioned seeing may be functionally related. Additionally, there were significant positive correlations between participants' stimulus control for conditioned seeing and participants' overall *iReady*® Winter reading diagnostic scores, r (47) = .482, p = <.001 and participants' overall *iReady*® Spring reading diagnostic scores, r (47) = .449, p = <.001. Results also indicate that there are significant positive correlations between conditioned seeing and participants' *iReady*® sub-scores for literature comprehension in the Winter, r (47) = .525, p <.001 and Spring, r (47) = .515, p <.001; informational text comprehension in the Winter, r (47) = .454, p =.001 and Spring, r (47) = .444, p =.001; and vocabulary scores in the Winter, r (47) = .355, p = .012 and Spring, r (47) = .500, p <.001. Table 2 displays a summary of these results. Table 3 displays the R^2 value between conditioned seeing and measures for which significant correlations were found. Participants' stimulus control for conditioned seeing explained a range of 14.5% to 28.1% of variance across Inc-BiN and reading achievement.

Spearman's rank correlation was computed to assess the relationship between participants' stimulus control for conditioned seeing and their performance percentiles on the *iReady® K-12 Adaptive Reading* diagnostic for the Winter and Spring. Results indicate that there were significant positive correlations between participants' Winter performance percentile, r (47) = .356, p = .012 and participants' Spring performance percentile, r (47) = .470, p = .001. Table 4 displays a summary of these results.

Table 2

Pearson's Correlation Coefficient Test Between Conditioned Seeing, Inc-BiN, and Reading Achievement

	1	2	3	4	5	6	7	8	9	10	11
1. Conditioned Seeing	--										
2. Untaught Listener (Inc-UniN)	.440**	--									
3. Untaught Speaker (Inc-BiN)	.384**	.663**	--								
4. Winter Overall iReady Score	.482**	.089	.384**	--							
5. Winter Lit Comp.	.525**	.118	.350*	.946**	--						
6. Winter Info Comp.	.454**	.057	.304*	.911**	.862**	--					
7. Winter Vocabulary	.355*	-.008	.345*	.865**	.810**	.816**	--				
8. Spring Overall iReady Score	.530**	.136	.379**	.940**	.900**	.881**	.859**	--			
9. Spring Lit Comp.	.515**	.087	.323*	.894**	.879**	.833**	.780**	.908**	--		
10. Spring Info Comp.	.444**	.152	.324*	.860**	.859**	.838**	.782**	.939**	.819**	--	
11. Spring Vocabulary	.500**	.071	.402**	.893**	.832**	.853**	.836**	.960**	.823**	.892**	--
Mean	6.88	18.10	8.80	427.51	434.06	431.12	422.18	449.57	456.59	456.59	445.47
SD	3.00	5.63	6.04	70.08	72.82	77.32	74.13	77.15	80.98	83.18	82.97

Note. Significance levels: $*p < .05$, $**p < .01$; Inc-UniN= Incidental Unidirectional Naming; Inc-BiN = Incidental Bidirectional Naming; Lit = Literature Comprehension; Info = Informational Comprehension; SD = Standard Deviation.

Table 3

Percentage of Variance Explained by Conditioned Seeing for Inc-BiN and Reading Achievement

Variable	% Of Variance (R^2)
1. Untaught Listener (Inc-UniN)	19.36
2. Untaught Speaker (Inc-BiN)	14.75
3. Winter Overall iReady Score	23.23
4. Winter Lit Comp.	27.56
5. Winter Info Comp.	23.43
6. Spring Overall iReady Score	28.10
7. Spring Lit Comp.	26.52
8. Spring Info Comp.	19.71
9. Spring Vocabulary	25.00

Note. Only R^2 for significant correlations shown; Inc-UniN= Incidental Unidirectional Naming; Inc-BiN = Incidental Bidirectional Naming; Lit = Literature Comprehension; Info = Informational Comprehension.

Table 4

Spearman's Rank Correlation Coefficient Test Between Conditioned Seeing and Performance Percentile

	1	2	3
1. Conditioned Seeing	--		
2. Winter Percentile	.356*	--	
3. Spring Percentile	.470**	.931**	--
Mean	6.88	47.55	49.73
SD	3.00	33.27	33.61

Note. Significance levels: *p < .05, **p < .01

2.2.2 Differences in Mean Values of Inc-BiN and Reading Diagnostic Scores

Independent samples t-tests were conducted to compare the means of (a) Inc-UniN; (b) Inc-BiN; (c) overall *iReady® K-12 Adaptive Reading* diagnostic scores (e) literature comprehension scores; (f) informational text comprehension scores; and (g) vocabulary scores for both the Winter and Spring diagnostics. The participants were grouped by low and high levels of stimulus control for conditioned seeing based on the number of correct drawing responses emitted across the three drawing probes. If a participant emitted 0 to 7 correct drawing responses, they were placed in the "low" stimulus control group and if a participant emitted 8 to 15 correct drawing responses, they were placed in the "high" stimulus control group.

Regarding increments of Inc-BiN, there were significant differences in untaught listener and untaught speaker responses. Participants with higher stimulus control for conditioned seeing had a statistically significant higher mean in untaught listener responses (*M* = 20.37, *SD* = 5.39 than participants with low stimulus control for conditioned seeing (*M* = 16.67, *SD* = 5.37). The same effect is seen for untaught speaker responses: participants with higher stimulus control for conditioned seeing demonstrated a statistically significantly higher mean in untaught speaker responses (*M* = 10.84, *SD* = 6.88) than participants with lower stimulus control for conditioned seeing (*M* = 7.50, *SD* = 5.40). Table 5 displays a summary of these results.

Regarding the Winter *iReady*® diagnostic, there were statistically significant differences across overall *iReady*® *K-12 Adaptive Reading* diagnostic scores, literature comprehension scores, and informational text comprehension scores. Participants with higher stimulus control for conditioned seeing had a statistically significant higher mean in their overall *iReady*® reading diagnostic score (*M* = 476.16, *SD* = 80.57) than those with low stimulus control for conditioned seeing (*M* = 405.57, *SD* = 51.91); they also achieved statistically significant higher scores for literature comprehension (*M* = 476.16, *SD* = 407.40) than those with low stimulus control for conditioned seeing (*M* = 407.40, *SD* = 53.41); and achieved statistically significant higher scores for information text comprehension (*M* = 466.68, *SD* = 84.71) than those with low stimulus control for conditioned seeing (*M* = 411.70, *SD* = 63.44). Table 5 displays a summary of these results.

Regarding the Spring *iReady*® diagnostic, there were significant differences across overall *iReady*® *K-12 Adaptive Reading* diagnostic scores, literature comprehension scores, informational text comprehension scores, and vocabulary scores. Participants with higher stimulus control for conditioned seeing had a statistically significant higher mean in their overall *iReady*® reading diagnostic score (*M* = 487.16, *SD* = 80.62) than those with lower stimulus control for conditioned seeing (*M* = 425.77, *SD* = 65.62); achieved statistically significant higher scores for literature comprehension (*M* = 500.68, *SD* = 88.97) than those with lower stimulus control for conditioned seeing (*M* = 428.67, *SD* = 62.14); achieved statistically significant higher scores for information text comprehension (*M* =492.21, *SD* = 80.95) than those with lower stimulus control for conditioned seeing (*M* = 433.53, *SD* = 77.48); and achieved statistically significant higher scores in vocabulary (*M* = 481.42, *SD* = 83.457) than those with lower stimulus control for conditioned seeing (*M* = 422.70, *SD* = 75.41). Table 6 displays a summary of these results.

Table 5

Differences in Stimulus Control for Inc-BiN as a Function of Low and High Stimulus Control for Conditioned Seeing

	Low n = 30		High n = 19				
	M	SD	M	SD	*t*	*df*	Sig. (2-tailed)
Untaught Listener Responses	16.67	5.37	20.37	5.39	-2.35	47	<.001
Untaught Speaker Responses	7.50	5.40	10.84	6.88	-1.94	47	.023

Note. Untaught listener and speaker responses were measured by point-to responses and interverbal responses, respectively, during Inc-BiN probes.

Table 6

Differences in Winter and Spring Reading Scores as a Function of Low and High Stimulus Control for Conditioned Seeing

	Low n = 30		High n = 19				
	M	SD	M	SD	*t*	*df*	Sig. (2-tailed)
Winter Overall iReady Score	405.57	51.91	462.16	81.76	-2.69	27.26	.012
Winter Lit Comp.	407.40	53.41	476.16	80.57	-3.29	28.06	.003
Winter Info Comp.	408.60	63.95	466.68	84.71	-2.56	30.84	.016
Winter Vocabulary	411.70	63.44	438.74	87.74	-1.16	29.86	.254
Spring Overall iReady Score	425.77	65.62	487.16	500.68	-2.92	47	.005
Spring Lit Comp.	428.67	62.14	480.62	88.97	-3.08	29.116	.004
Spring Info Comp.	433.53	77.48	492.21	80.95	-2.54	47	.014
Spring Vocabulary	422.70	75.41	481.42	83.57	-2.49	47	.014

Note. Lit = Literature Comprehension; Info = Informational Comprehension

2.3 Discussion

This study tested the associations between conditioned seeing and measures of reading achievement for 49 participants in kindergarten through second grade. Correlation analyses demonstrated that participants' stimulus control for conditioned seeing was significantly correlated with all measures of reading achievement across Winter and Spring diagnostics as well as the stimulus control for Inc-UniN and Inc-BiN. Group differences demonstrated that students with higher stimulus control for conditioned seeing (i.e., more accurate drawing responses) achieved higher means in untaught listener and speaker responses as well as higher means in most reading achievement measures.

Though conditioned seeing explains 19.36% of untaught listener responses and 14.75% of untaught speaker responses, the existence of significant positive correlations between conditioned seeing and Inc-BiN coupled with the significant group differences in untaught listener and speaker responses as a function of low and high stimulus control for conditioned seeing highlight the existence of a relationship. The variance across untaught listener and speaker responses is also affected by the existing verbal behavior repertoires, meaning that existing cusps in a students' repertoire affect their stimulus control for Inc-BiN. Though that is true, results demonstrate the need to further investigate whether the stimulus control for conditioned seeing and the strength of Inc-BiN stimulus control are functionally related.

In 2018, Syed investigated the functional relationship between conditioned seeing and Inc-BiN for students in third through fifth grade. Syed's results demonstrated that the establishment of Inc-BiN and the establishment of conditioned seeing were functionally related as she found that multiple exemplar instruction (MEI) across listener, speaker, and drawing responses established both Inc-BiN and conditioned seeing. Though Syed's (2018) study provides evidence that conditioned seeing and Inc-BiN are functionally related for students in third through fifth grade, it does not answer whether the same is true for students in kindergarten through second grade.

Furthermore, the correlation and variance between conditioned seeing and stimulus control for untaught listener responses was greater than the correlation and variance between conditioned seeing and the stimulus control for untaught speaker responses, which provides empirical evidence that conditioned seeing is likely an extension of the listener repertoire. These results differ from Shanman's (2013) findings. One possible explanation for this is the difference in sample sizes and participant demographics as more participants with the UniN were included in this analysis than participants with BiN. Though conditioned seeing in this study was measured by a production response, the stronger correlation to untaught listener responses over untaught speaker responses can be explained by the covert process of conditioned seeing responses.

As defined by Skinner (1957), a conditioned seeing response is a covert visual response for a given stimulus in the absence of its physical stimulus. This process relies on participants' listener repertoire to attend to their covert visualizations of the symbol prior to emitting an overt behavior like drawing the symbol. To use Skinner's example involving the death of Little Nell, the reader relied on his/her listener repertoire while textually responding to the text *and* while visualizing of the events described via the text prior to emitting any emotional response. Thus, when participants in this study were asked to "Draw the symbols they had just seen," the participants had to first engage in the covert behavior of visualizing the unfamiliar stimuli prior to emitting a drawing response, which I argue is a type of listener behavior, resulting in a stronger correlation with untaught listener responses.

This hypothesis may also provide insight into why students with higher stimulus control for conditioned seeing achieved greater differences in untaught listener responses than untaught speaker responses. Those participants who had a stronger stimulus control for conditioned seeing also demonstrated a stronger stimulus control for Inc-UniN, which suggests that the greater stimulus control to attend to one's own covert behavior of seeing stimuli in the absence of its physical stimulus results in a stronger stimulus control for incidental object-word relations as a listener (i.e., Inc-UniN). Similarly, it can also be argued that greater stimulus control for Inc-UniN results in a stronger stimulus control for conditioned seeing, which resulted in higher accurate drawing responses.

Conditioned seeing as an extension of the listener repertoire perhaps makes more logical sense when viewed in the context of the reader-as-own listener repertoire. Greer and Speckman

(2009) argue that reader-as-own-listener repertoire is an extension of the speaker-as-own listener repertoire. The process of reading involves an individual's behavior being under the stimulus control of print to elicit textual responding behavior, which is a form of speaker behavior. The reader must also act as a listener to listen to his/her textual responses such that he or she comprehends what was just read (Greer & Speckman, 2009; Mercorella, 2017). Viewing conditioned seeing as an extension of the reader-as-own listener repertoire may also explain the significant correlations and significant differences between conditioned seeing and reading achievement measures.

Conditioned seeing was significantly correlated with all measures of reading achievement and most importantly, significant differences in overall *iReady*® reading diagnostic scores and reading comprehension scores for literature and informational text were found. The percentage of variance explained by participants stimulus control for conditioned seeing was greater across overall reading scores and scores for literature comprehension and informational comprehension. These results support the hypothesis that conditioned seeing is an extension of the reader-as-own listener repertoire since greater stimulus control for conditioned seeing indicated better reading achievement and reading comprehension, which is evidence of an existing reader-as-own listener repertoire. Though additional variance for reading achievement can be explained by exposure to curriculum and how developed participants' reader repertoire were at the onset of the study, the additional significant correlation between participants' stimulus control for conditioned seeing and their performance percentile on the *iReady*® reading diagnostic in both the Winter and Spring assessments further validate the critical role conditioned seeing is suggested to have in the reader-as-own listener repertoire.

2.5.1 Rationale for Experiment 2

Results from Experiment 1 suggest that conditioned seeing is related to Inc-BiN and reading achievement for students in kindergarten through second grade. The study demonstrates the need to further investigate whether the establishment of conditioned seeing will cause increases in the stimulus control for Inc-BiN and increases in reading achievement. It is imperative that more research on conditioned seeing is conducted to determine whether conditioned seeing is a critical piece that needs to be taught in the quest to mitigate reading comprehension difficulties; therefore, the purpose of the second experiment in the current study was to determine how the establishment of conditioned seeing affects increments of Inc-BiN and student performance in reading.

Previous literature has established conditioned seeing via MEI across listener, speaker, and drawing responses (Syed, 2018) and a sequencing reading intervention (Mercorella, 2017). To further extend the work of Hwang-Nesbit (2021), the current study implemented an academic-based MEI intervention across delayed selection and production responses, picture-to-words matching, and words-to-drawing matching to establish conditioned seeing. Reading performance measures include *WJIV®* Test 4: Passage Comprehension and Test 12: Reading Recall, experimenter-derived read-draw comprehension probes, and conditioned reinforcement for books without pictures probes. The measurement of conditioned seeing in Experiment 1 may be a possible limitation as participants all have different fine motor repertories that may have affected their ability to produce a drawing, which in turn, affected experimenter measurement of correct and incorrect responses for conditioned seeing. To address this, a different measurement procedure was used for Experiment 2 and will be discussed subsequently.

2.5.2 Research Questions for Experiment 2

Experiment 2 will answer the following research questions:

1. Does MEI across delayed selection and production responses establish the stimulus control for conditioned seeing in kindergarten students with and without disabilities?
2. Are there functional relations between the establishment of conditioned seeing and (a) Inc-BiN, (b) *WJIV*® subtests 4 and 12, (c) read-draw comprehension probes, and (d) conditioned reinforcement for books without pictures?

Chapter 3: Experiment 2

3.1 Method

3.1.1 Participants

Six kindergarten students, who were not part of Experiment 1, were selected to participate in Experiment 2 (see Table 7). Participants were selected from the same kindergarten classroom described in Experiment 1. There were three female and three male participants all between the ages of 5 and 6 years. Reading assessments conducted prior to the onset of the study indicated that all participants could textually respond to consonant-vowel-consonant (CVC) words and consonant-vowel-consonant-consonant (CVCC) words with at least 90% accuracy and textually respond to at least 25 sight words (i.e., words that are not phonetic) with 100% accuracy. Participants were selected because they demonstrated 60% or less correct matching responses (i.e., conditioned seeing responses) during initial conditioned seeing probe sessions and did not demonstrate Inc-BiN for unfamiliar stimuli during initial Inc-BiN probes. To increase the number of participants who would contact the intervention at the same time, the experimenter assigned participants to dyads randomly.

Table 7

Participant Demographics for Experiment 2

Dyad	Participant	Sex	Age	IEP	Race	Eligibility for Free/Reduced Lunch
1	1	M	5.33	N	H	N
	2	F	5.33	Y	H	N
2	3	F	6.00	N	W	N
	4	F	5.41	N	W	N
3	5	M	5.50	N	H	Y
	6	M	5.16	N	B	Y

Note. M = Male; F = Female; Age reflects participants' age at the onset of the study; IEP = Individualized Education Plan; H = Hispanic; W = White; B = Black.

3.1.2 Materials

Conditioned Seeing Probes

Materials used to measure participants' stimulus control for conditioned seeing included the five sets of novel visual stimuli and names used in Experiment 1 (see Table 1), and five additional sets of novel visual stimuli for a total of 10 sets (see Table 8). The five additional sets of stimuli were the same stimuli used in Syed's (2018) study. All symbols were paired with a mono-syllabic name and presented using Microsoft PowerPoint slideshow. Each slideshow contained 20 slides, four slides for each symbol. All sets were counterbalanced across participants and no two sets were presented more than once. During match-to-sample probes (i.e, conditioned seeing probes), participants were given a pencil, eraser, and matching sheet. Each matching sheet was a 21.69 cm by 27.94 cm page that contained a column for the target visual stimuli on the left and a column for the target written name for the visual stimuli on the right, see Appendix B.

Table 8

Additional Sets of Stimuli for Seeing Probes

Set 6	ծ	փ	կ	պ	ㅗ
	Lop	Dod	Tor	Giz	Rew
Set 7	Ղ	Գ	ረ	ㅑ	ƕ
	Nud	Wix	Tay	Hab	Fer
Set 8	又	月	王	巳	山
	Rup	Min	Tun	Hib	Vil
Set 9	ㄷ	ㄹ	ㅓ	ㅅ	ㅍ
	Ruk	Yut	Wiv	Raz	Vin
Set 10	ਗ	ي	ਧ	ა	ㄕ
	Biz	Pip	Paj	Tiv	Zad

Note. The same visual stimuli and names in sets 7-10 were used in Syed (2018), however the experimenter repaired visual stimuli and names such that all stimuli were paired with CVC words.

Inc-BiN Probes

Materials for Inc-BiN probes differ from Experiment 1. Seven sets of novel visual stimuli and names were used to measure participants' level of Inc-BiN. Each set contained three, two-syllable names, one multisyllabic novel name, and one monosyllabic novel name (see Table 9). For the naming experience, the sets of novel stimuli were presented using Google Slides where each slideshow contained 20 slides, four slides for each symbol in a rotated order. All sets were counterbalanced across participants and no two sets were presented more than once. During Inc-BiN probes, 10 additional slides were presented during the listener probe, each containing three symbols, and 10 additional slides were presented during the speaker probe, two slides for each of the target symbols.

Table 9

Sets of Stimuli for Inc-BiN Probes

Set 1	Bram	ほ Flogget	父 Sumeck	Destry	申 Cazzerly
Set 2	Foydot	ДК Moonter	∈ Lam	Ӝ Hinter	Dakum
Set 3	愛 Jap	Hieset	إ rudaper	formack	ȭ Algo
Set 4	nemesis	Herad	optic	lira	æ duvat
Set 5	york	₽ emtil	maroy	א chipul	Ψ stimmer
Set 6	ƀ ren	₹ index	kinset	pogo	grimerly
Set 7	Œ ban	ƛ verta	picket	州 gabanel	Θ nogul

Woodcock Johnson® Tests of Achievement

The *Woodcock Johnson® Tests of Achievement,* Fourth Edition (*WJIV®*; Schrank, Mather & McGrew, 2014) was used to measure participants' reading comprehension. Form A and Form B of the Standard Battery (i.e., subtests 1-11) and Extended Battery (i.e., subtests 12-20) Test Books were used to administer the reading comprehension cluster tests. The reading comprehension cluster was comprised of two tests: (1) Test 4: Passage Comprehension and (2) Test 12: Reading Recall. Data were recorded on corresponding Test Records for Form A and Form B.

Conditioned Reinforcement for Books Without Pictures

Materials used during probes for conditioned reinforcement for books without pictures included researcher-modified kindergarten leveled books (i.e., level A through C) from *Reading A-Z* (Learning A-Z, 2021). All pictures in books were covered such that only the print was shown on each page. A video recording device such as an iPad or computer was also used to record probe sessions.

Read-Draw Probes and MEI Intervention

For read-draw probes and the advanced phase of the MEI intervention, sets of researcher-modified sentences from the *Reading Wonders Kindergarten Curriculum* (McGraw Hill, 2012) were used. All participants had no prior exposure to the texts from which the sentences were selected. The researcher modified sentences such that each sentence contained five to eight words and three distinct nouns and/or verbs. Table 10, Table 11, and Table 12 show the sets of sentences that were used during read-draw probes and the advanced phase of MEI.

Sets of sentences used during read-draw probes were presented in the form of a 21.69 cm by 27.94 cm page showing five 4.47 cm by 19.38 cm blank rectangles, see Appendix C. Sets of sentences used during the advanced phase of MEI were presented on a laptop using Google Slides. Additional materials for the intervention included six sets of CVC words, matching pictures for target words and sentences, drawing sheets, and erasable colored pencils. Table 13 shows the sets of CVC words used during the training phase of intervention.

Table 10

Sentence Sets for Read-Draw Probes and Corresponding Components

Set 1	Components	Set 2	Components	Set 3	Components	Set 4	Components	Set 5	Components	Set 6	Components
Tim can sit to pat the cat.	○ Tim ○ Sit ○ Cat	Cam can pet the cat.	○ Cam ○ Pet ○ Cat	We can see the book.	○ We ○ See ○ Book	The cat and I go and sit.	○ Cat ○ I ○ Sit	Kim had a little rock.	○ Kim ○ Had ○ Rock	The rat was sad and hid in bed. *	○ Rat ○ Sad ○ Bed
Dad can fit five in the van.	○ Dad ○ Five ○ Van	Kim had to sip a cup*.	○ Kim ○ Sip ○ Cup	Kim had a red rock. *	○ Kim ○ Had ○ Rock	Kim and Nan sat and sat.	○ Kim ○ Nan ○ Sat	Ron can sit and sip.	○ Ron ○ Sit ○ Sip	We sit in a den. *	○ We ○ Sit ○ Den
Nap and Tip toss the ball. *	○ Nap ○ Tip ○ Ball	Ben has a black cat on a rug.	○ Ben ○ Cat ○ Rug	Zeb can sit and ride a bus.	○ Zeb ○ Sit ○ Bus	A red hat is on Kim.	○ Red hat ○ On ○ Kim	I sit on a rock in the sun.	○ I ○ Rock ○ Sun	The dog had to sit in a bin. *	○ Dog ○ Sit ○ Bin
Tom can ride a red bike.	○ Tom ○ Ride ○ Red bike	Zeb and Zot get on a big jet. *	○ Zeb ○ Zot ○ Jet	Zeb can see a big sun and bug. *	○ Zeb ○ Sun ○ Bug	Zeb and Pop hug.	○ Zeb ○ Pop ○ Hug	Deb can hit with a bat.	○ Deb ○ Hit/holding bat ○ Bat	Kat and Pam had a kite.	○ Kate ○ Pam ○ Kite
Nat and Tip like to sip.	○ Nat ○ Tip ○ Sip	Jan and Pete can take the bus.	○ Jan ○ Pete ○ Bus	Tim can hug the black cat. *	○ Tim ○ Hug ○ Cat	Cam can go sit when sad. *	○ Cam ○ Sit ○ Sad	Tom can ride a red van.	○ Tom ○ Ride ○ Red van	I like to pat the dog.	○ I ○ Pat ○ Dog

Note: Asterix indicates that the original sentence was modified by the researcher

Table 11

Sentence Sets for Read-Draw Probes and Corresponding Components Continued

Set 7	Components	Set 8	Components	Set 9	Components	Set 10	Components	Set 11	Components	Set 12	Components
Dad and I like to see a fish. *	○ Dad ○ I ○ Fish	Mom had hot ham for Ben. *	○ Mom ○ Ham ○ Ben	Ben can pack a bat in a bag. *	○ Ben ○ Bat ○ Bag	Pop and I can sip.	○ Pop ○ I ○ Sip	Sam can pat the ball.	○ Sam ○ Pat ○ Ball	Fin and I can swim. *	○ Fin ○ I ○ Swim
My big pup and cat tug.	○ Pup ○ Cat ○ Tug	I wash Gus in the tub. *	○ I ○ Gus ○ Tub	I can see six pigs! *	○ I ○ Six ○ Pigs	Pam and mom can see a pen. *	○ Pam ○ Mom ○ Pen	Pam and mom can see a pot. *	○ Pam ○ Mom ○ Pot ○	Mom and I play in the sand.	○ Mom ○ I ○ Sand
Bill and Dan make a bed. *	○ Bill ○ Dan ○ Bed	Jake and Dale help dad.	○ Jake ○ Dale ○ Dad	Dad and I see a bus. *	○ Dad ○ I ○ Bus	In the sun, Pam can lick a pop. *	○ Sun ○ Pam ○ Pop	The frog can see a black bug. *	○ Frog ○ Black ○ Bug	Nat and his dog see the kids. *	○ Nat ○ Dog ○ Kids
We go on a swing with dad.	○ We ○ Swing ○ Dad	We sit and play in the mud. *	○ We ○ Sit ○ Mud	Nan and Lin feed hens *	○ Nan ○ Lin ○ Hens	Sam can pat the cap.	○ Sam ○ Pat ○ Cap	We see the bird and cat.	○ We ○ Bird ○ Cat	Tim and mom dig*	○ Tim ○ Mom ○ Dig
The dog and I are on a rug.	○ Dog ○ I ○ Rug	The vet pets the dog. *	○ Vet ○ Pets ○ Dog	The dog and I are sad. *	○ Dog ○ I ○ Sad	Sid and Tod pat a ball.	○ Sid ○ Tod ○ Ball	I put a big box in a van! *	○ I ○ Box ○ Van	We are on a ship. *	○ We ○ On ○ Ship

Note: Asterix indicates that the original sentence was modified by the researcher

Table 12
Sentence Sets for Read-Draw Probes and Corresponding Components Continued

Set 13	Components	Set 14	Components
She gets her hat and mittens. *	○ She ○ Hat ○ Mittens	Dan and I see drums. *	○ Dan ○ I ○ Drums
Dan and I see dogs. *	○ Dan ○ I ○ Dogs	I help dad with the bags. *	○ I ○ Dad ○ Bags
We sit on the bench. *	○ We ○ Sit ○ Bench	A pup can lick me.	○ Pup ○ Lick ○ Me
We put a box in the truck. *	○ We ○ Box ○ Truck	I put on a red sock and hat. *	○ I ○ Red Sock ○ Hat
We go under a tree. *	○ We ○ Under ○ Tree	We can put a hut on the grass.	○ We ○ Hut ○ Grass

Note: Asterix indicates that the original sentence was modified by the researcher

Table 13

Sets of CVC words used during Training Phase of Intervention

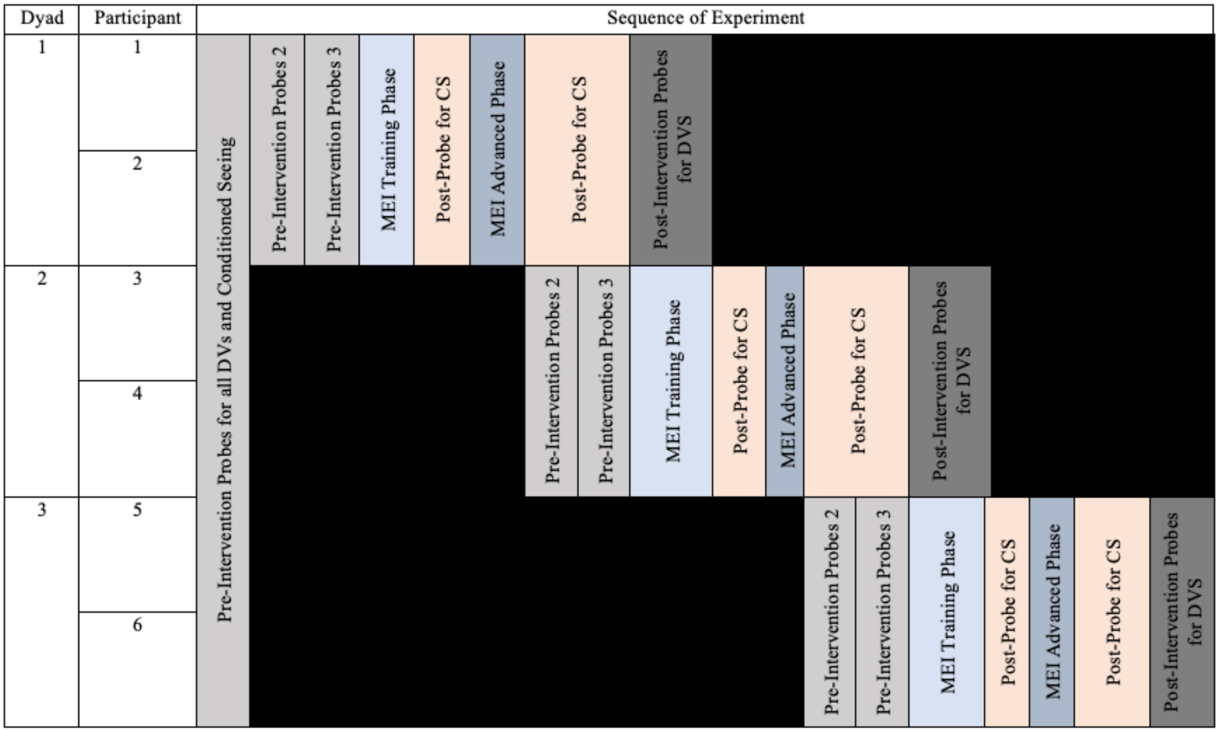
Set 1	Set 2	Set 3	Set 4	Set 5	Set 6
yam	ram	hut	mug	tag	fig
cot	den	pan	pot	yam	cog
pad	tag	cab	cop	pot	pan
cod	rag	jug	sip	mug	den
fig	cog	hug	pin	yam	ram

3.1.3 Experimental Design

A pre and posttest design with an embedded multiple probe design across dyads was used. The pre and posttest design was used to measure the effects of the establishment of conditioned seeing on Inc-BiN, reading comprehension, and conditioned reinforcement for books without pictures. The multiple probe design across dyads was used to test the effects of an MEI across delayed selection and production responses intervention on the establishment of conditioned seeing. Figure 1 displays a visual for the experimental design used.

Figure 1

Sequence of Experiment 2



Note. This figure displays the pre and post experimental design with an embedded multiple probe design. Light grey boxes indicate pre-intervention probes and dark grey boxes indicate post-intervention probes for dependent variables. Light blue boxes and dark blue indicate the MEI across delayed selection and production responses. Black boxes indicate phases where no probe session or intervention sessions were conducted.

Initial probes were conducted for all participants at the same time for the following variables: (1) conditioned seeing, (2) Inc-BiN (3) read-draw comprehension probes, and (3) conditioned reinforcement for books without pictures. At least two additional probes for the previously mentioned variables and pre-probes for the *WJIV*® Tests 4 and 12 were administered prior to the implementation of the intervention for each participant superimposed over the time of the study. Target stimuli for each dependent variable were counterbalanced across participants (see Table 14).

Target stimuli for the intervention were also counterbalanced across participants (see Table 15). Multiple probe logic determined when participants entered the intervention as well as the intervention's effectiveness on the establishment of conditioned seeing. To control for maturation and instructional history, the first dyad commenced intervention while all other dyads remained in baseline conditions (i.e., a between-subjects logic). Once the first dyad demonstrated criterion for the training phase and advanced phase of the intervention, post-probes with the same initial set as baseline were conducted for conditioned seeing. Following an increase in conditioned seeing responses for the first dyad, the second dyad began intervention. The same procedure was repeated until all participants had entered intervention. Criterion to cease intervention was the establishment of conditioned seeing. Criterion for the establishment of conditioned seeing was set at 5/5 correct matching responses across two initial probe sets followed by 11/15 (70%) correct responses across three novel probes for conditioned seeing. Once conditioned seeing was established, post-intervention probes for Inc-BiN, reading comprehension, conditioned reinforcement for books without pictures, and *WJIV*® Tests 4 and 12, were conducted.

Table 14
Assignment of Stimuli Sets for Independent and Dependent Variables

Variable	Probe	Participant					
		1	2	3	4	5	6
Conditioned Seeing	Initial Set 1	2	5	3	5	2	1
	Initial Set 2	1	3	1	4	4	2
	Initial Set 3	5	1	2	3	3	5
	Initial Set 4	-	-	-	-	5	3
	Novel 1	3	2	4	1	6	4
	Novel 2	4	4	5	2	1	7
	Novel 3	6	7	6	7	10	6
	Novel 4	-	-	-	6	-	10
	Novel 5	-	-	-	9	-	8
	Novel 6	-	-	-	8	-	9
Inc-BiN	Pre 1	3	1	3	5	2	1
	Pre 2	4	3	5	2	4	3
	Pre 3	2	5	1	4	3	4
	Pre 4	-	-	-	-	1	2
	Post 1	1	6	2	3	7	5
	Post 2	5	2	6	1	6	7
	Post 3	6	4	4	7	5	6
Read Draw	Pre 1	4	5	2	3	3	4
	Pre 2	2	3	1	4	2	3
	Pre 3	1	4	3	5	5	2
	Pre 4	5	-	5	2	1	5
	Post 1	8	6	9	14	4	6
	Post 2	11	2	7	1	7	1
	Post 3	9	8	12	13	9	14
WJIV®	Pre	Form B	Form B	Form A	Form A	Form B	Form B
	Post	Form A	Form A	Form B	Form B	Form A	Form A

Table 15

Assignment of Stimuli Sets to Participants for Intervention

Intervention Phase	Intervention Sessions	Participant					
		1	2	3	4	5	6
Training Phase	1	2	1	3	4	5	6
	2				-		
	3	-		-	-	-	-
Advanced Phase	1	6	7	10	11	9	8
	2			7	6		
	3	8		9	9	12	6
	4	-	9	6	8		-
	5	-		11	10	7	-
	6	-	11	8		-	-
	7	-		12	-	-	-

3.1.4 Dependent Variables

The study had three dependent variables for reading performance: (1) read-draw probes, (2) Test 4: Passage Comprehension and (3) Test 12: Reading Recall from the *WJIV*® Tests of Achievement and (3) conditioned reinforcement for books without pictures. The fourth and last dependent variable was Inc-BiN for unfamiliar stimuli.

Reading Comprehension

Read-Draw Probes. To measure participants' reading comprehension, read-draw probes were conducted. Each read-draw probe consisted of five researcher-modified sentences comprised of four to eight CVC words, CVCC words, and/or sight words (see Tables 10, 11 and 12). Each sentence contained three distinct components (i.e., nouns and/or verbs) that participants were required to draw to demonstrate proficient reading comprehension, thus each probe was out of a total of 15 components. A correct response for a component was recorded if the participant drew picture for a component in his or her drawing and an incorrect response was recorded if the participant omitted the component in his or her drawing, see Appendix D and Appendix E for examples of correct and incorrect drawing responses, respectively.

***WJIV*® Reading Comprehension Cluster.** The *Woodcock Johnson® Tests of Achievement* is designed to measure academic achievement and cognitive development across reading, mathematics, and writing domains (Schrank, Mather, & McGrew, 2014). The reading comprehension cluster was used to also measure participants' reading comprehension. The reading cluster consisted of Test 4: Passage Comprehension and Test 12: Reading Recall. Test 4 measured participants' ability to point to a corresponding picture given a phrase and participants' ability to identify a corresponding word given a sentence. Test 12 measured participants' accuracy in retelling a story to predetermined feature points after covertly reading a short story.

Correct and incorrect responses were recorded based on instructions provided for each subtest. Form A and Form B were counterbalanced across pre-intervention probes and post-intervention probes such that a different form was used for each probe session (see Table 14).

Conditioned Reinforcement for Books without Pictures

Conditioned reinforcement for books without pictures was measured during a 5-min reading period. The 5-min reading period was divided into 5-s intervals and whole interval recording was used. A correct 5-s interval was recorded if the participant observed the printed text by moving his or her eyes across the sentence from left to right, textually responded to the printed text, or was attempting to vocally sound out a printed word. A correct 5-s interval was still recorded if the participant engaged in any of the following behaviors: (a) paused to turn to the next successive page, (b) if the participant was reading immediately prior to closing a given book, (c) continued to visually attend to book stimuli while selecting a new book, and (d) selected a new book and began reading. An incorrect 5-s interval was marked if the participant stopped observing the printed text and engaged in other behavior, such as interacting with peers, attending to other stimuli in the environment, or if the participant was flipping through pages quickly, skipping pages, or passively pointing to words (i.e., the absence of eye movements that indicate reading).

Stimulus Control for Inc-BiN

Participants' stimulus control for Inc-BiN was measured using the same numerical measure used in Experiment 1 for untaught listener (i.e., point-to) and untaught speaker (i.e., intraverbal) responses. The number of correct responses indicated the stimulus control for acquiring incidental word-object relations. Inc-BiN probes for each participant were conducted in the same manner described in Experiment 1 but with stimuli from Table 9.

3.1.5 Independent Variable

The independent variable was the establishment of conditioned seeing using multiple exemplar instruction across delayed selection and production responses. The intervention consisted of two phases, a training phase, and an advanced phase. The training phase consisted of multiple exemplar instruction across delayed selection and production responses for CVC words and the advanced phase consisted of multiple exemplar instruction across delayed selection and production responses for sentences. Figure 2 demonstrates the sequence for the intervention.

Training Phase: CVC Words

In the training phase, (1) selection (i.e., point-to) responses for pictures after textually responding to CVC words, (2) selection (i.e., point-to) responses for CVC words after a 5 s observation of a picture, and (3) drawing (i.e., production) responses after textually responding to CVC words were taught. During this phase, the researcher selected five CVC words for instruction that were novel to the participant. Each intervention session consisted of two opportunities to respond to each response topography for each of the five words for a total of 30 intervention trials. Each response topography and target word were rotated such that no topography and target word were presented consecutively. The intervention session used learn unit instruction where reinforcement, in the form of tokens and praise, was given for correct responses and a correction procedure was administered if the participant emitted an incorrect response. The correction procedure included the researcher modeling the correct response followed by an opportunity for the participant to emit the corrected response independently that was not reinforced. If the participant continued to emit incorrect responses, the correction procedure was implemented up to three times prior to continuing onto the next learn unit.

Criterion for the training phase was 90% correct responding or higher across one intervention session.

Advanced Phase: Sentences

Phase A. In the Advanced Phase A, (1) selection (i.e., point-to) responses for pictures after textually responding to sentences, (2) selection (i.e., point-to) responses for matching sentences given a picture, and (3) drawing (i.e., production) responses after textually responding to sentences were taught. During this phase, the researcher selected five sentences for instruction. Each intervention session consisted of two opportunities to respond to each response topography for each of the five sentences for a total of 30 intervention trials. Each response topography and target sentence were rotated such that no topography and target sentence were presented consecutively. The intervention sessions also used learn unit instruction where reinforcement was given for correct responses and a correction procedure was administered following incorrect responses as described above. Criterion for this phase was 90% correct responding or higher across one intervention session.

If participants achieved criterion during Phase A and did not demonstrate increases in conditioned seeing responses during post-intervention conditioned seeing probes, Phase A continued. Additional intervention sessions were conducted with a novel set of sentences. This was repeated until the participant achieved criterion for conditioned seeing responses across initial probe sets.

Phase B. If participants achieved criterion for the advanced phase in one session across two advanced intervention phases, they entered Phase B of the advanced phase. During Phase B, three consecutive intervention sessions were conducted across three novel sets of sentences to increase participant exposure to the intervention.

Phase C. If the participant did not achieve criterion for conditioned seeing after Phase B, he or she entered Phase C of the advanced phase. During Phase C, three additional intervention sessions were conducted with the inclusion of an additional production response topography. The additional production response topography required the participant to observe a picture and vocally produce a sentence describing the picture. A correct vocal sentence was recorded if the participant vocally identified the subjects (i.e., nouns) and action (i.e., verb) in their vocal sentence. An incorrect vocal sentence was recorded if the participant did not vocally identify all the subjects and/or action in the picture or if the participant did not emit any vocal response. Once criterion was met for Phase C post conditioned seeing probes were conducted.

Conditioned Seeing

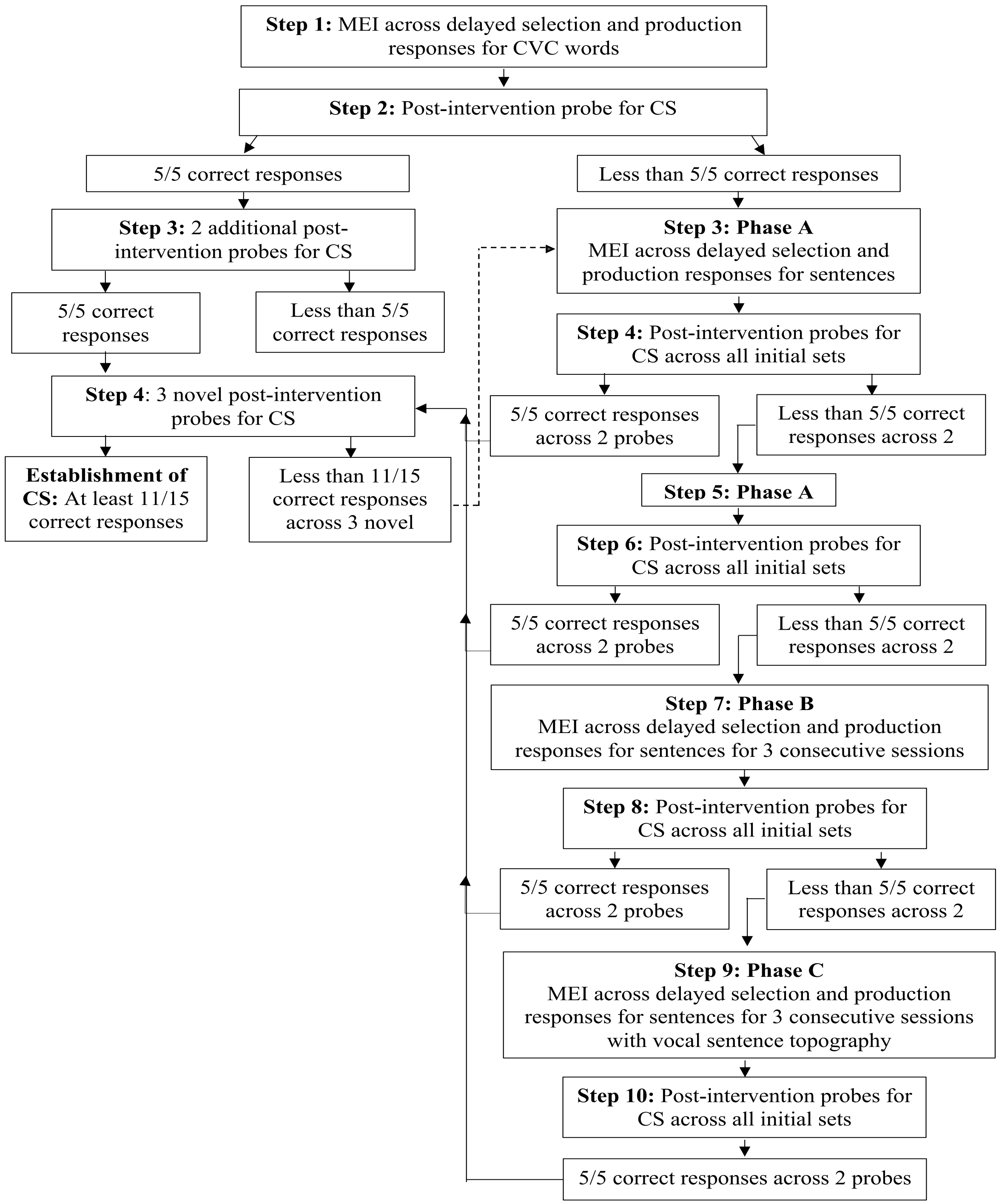
The stimulus control for conditioned seeing for each participant were measured by selection responses for novel unfamiliar stimuli instead of the drawing probes used in Experiment 1. By using selection responses, conditioned seeing was objectively measured as it removed subjectivity when measuring accurate responses. The same stimuli as used in Shanman (2013), Mercorella (2017), and Syed (2018) were used for conditioned seeing probes, however, the procedure was modified.

Instead of conducting a conditioned seeing probe immediately after an Inc-BiN probe, a separate naming experience, using the same procedure as Inc-BiN, for target stimuli was given followed by a period of at least 2 hours. After a period of at least 2 hours, a conditioned seeing probe was conducted where participants were required to select the printed picture after textually responding to a printed word by drawing lines. Selection responses were a measure of conditioned seeing since participants were required to textually respond to each printed word prior to selecting its picture it in an array of the five target symbols. It was hypothesized that when participants textually responded to the name of the target stimuli, it would evoke a covert visualization response (i.e., conditioned seeing) such that the participants could select the corresponding visual stimulus. A correct selection response was recorded if the participant accurately selected the corresponding symbol after textually responding to its printed word and an incorrect matching response was recorded if the participant did not select the corresponding symbol after textually responding to its printed word or if no response was given.

Conditioned seeing was considered established when the participant emitted five correct selection responses for at least two initial probe sets and when the participant emitted at least 11 correct selection responses across three novel probe sets (70% accuracy overall). If the participant did not demonstrate the establishment of conditioned seeing after the training phase and advanced phase, he or she returned to the advanced phase of intervention with five novel sentences. This process was repeated with additional phases of the advanced phase until participants demonstrated the establishment of conditioned seeing (see Figure 2).

Figure 2

Sequence of MEI Across Delayed Selection and Production Responses Intervention



Note. CS = conditioned seeing

3.1.6 Procedure and Data Collection

Conditioned Seeing Probes and Prerequisite Probes

To begin, each participant sat across from or next to the researcher. The researcher presented a naming experience, in the same way as Inc-BiN probes for Experiment 1. Following a period of at least two hours, a conditioned seeing probe was conducted. The researcher gave the participant a sheet and other materials and delivered the vocal antecedent "Read each word. When you read each word, match the symbols to the words by drawing lines." The participant was given an unlimited amount of time to complete the probe and the probe ended when the participant selected all five symbols after textually responding to the printed words or if they indicated that they were finished.

Inc-BiN Probes

Inc-BiN probes were be conducted in the same manner as described in Experiment 1 with sets from Table 9.

Read-Draw Probes

For each read-draw probe, each participant sat across from or next to the researcher. The researcher gave the participant a drawing sheet that contained five researcher-modified sentences (see Appendix C for examples of drawing sheets). The researcher instructed the participant to read the first sentence and after the participant textually responded to the sentence, the researcher gave the vocal direction "Draw a picture to match the sentence." The participant was given unlimited time to draw his or her picture. When the participant vocally stated that he or she was done, the researcher instructed the participant to read the next sentence and instructed the participant to draw the corresponding picture. This process continued until the participant textually responded to all five sentences and had the opportunity to produce five drawings. All responses were unconsequated.

Conditioned Reinforcement for Content Probes

To begin a probe for books without pictures, the researcher set up a recording device 1 to 2 ft away from the participant and provided him or her 12-15 kindergarten leveled books to read. The researcher instructed the participant that he or she was going to read books for 5 minutes and recorded the participant for a 5-min period. Once the 5-minute period elapsed, the researcher stopped recording. The researcher reviewed the video footage and used 5-s whole interval recording to determine the total number of intervals the participant observed books without pictures as a measure of conditioned reinforcement.

WJIV® Reading Comprehension Cluster

The researcher administered Test 4: Passage Comprehension and Test 12: Reading Recall from *WJIV®* immediately prior to the start of intervention. The researcher first administered Test 4 followed by Test 12. Both tests were administered using procedures provided by the test record. The researcher discontinued testing for Test 4 when the participant achieved a predetermined number of incorrect responses and discontinued testing for Test 12 when the participant did not achieve enough feature points to proceed to the next passage.

Multiple Exemplar Instruction Across Words and Pictures

Training Phase. All participants began in the training phase of the intervention (Figure 2, Step 1). To begin, the researcher explained to the participant that they are going to play a matching game. The researcher then presented the first CVC word and instructed the participant to textually respond out loud to the word. Once the participant textually responded to the first target CVC word, the researcher removed the CVC word and presented an array of three pictures, one target picture that matched the CVC word and two non-target pictures. Upon the presentation the pictures, the researcher delivered the vocal antecedent, “Point to the picture that matches the word you just read.” If the participant pointed to the correct picture, the researcher delivered praise and tokens; however, if the participant pointed to the incorrect picture, the researcher modeled the correct point-to response and re-presented the vocal antecedent. The correction procedure continued up to three times.

Next, the researcher presented a picture that corresponded to the next target CVC word for 5 s and instructed the participant to look at the picture. After 5 s, the experimenter removed the picture and presented the participant with an array of three CVC words, one target CVC word and two non-target CVC words and delivered the vocal antecedent, “Point to the word that matches the picture you just saw.” If the participant pointed to the correct CVC word, the researcher delivered praise and tokens, however if the participant pointed to the incorrect CVC word, the correction procedure previously described was implemented.

Then, the researcher presented the next target CVC word and instructed the participant to textually respond to the word. Once the participant textually responded to printed word, the researcher delivered the vocal antecedent, “Draw a picture that matches to the word you just read. Tell me when you are done.” The participant was given unlimited time to draw a picture and once completed, the researcher delivered praise and tokens for correct responses and implemented the correction procedure for incorrect responses. The correction procedure differed in that the researcher showed the correct matching picture followed by the opportunity to redraw his or her picture. The rotation of target response topographies and target words continued until all 30 learn units were delivered across the five target CVC words.

Once criterion was achieved for the training phase, one post-intervention probe for conditioned seeing was conducted using one of the same initial sets as baseline (Step 2, Figure 2). If the participant demonstrated 5/5 correct matching responses during this post-conditioned seeing probe, two additional conditioned seeing probes with two additional initial probe sets were conducted (Step 3, Figure 2). If the participant did not demonstrate 5/5 correct matching responses during this first post-conditioned seeing probe, the participant continued onto the advanced phase of intervention (Step 3: Advanced Phase, Figure 2).

Advanced Phase. In the advanced phase of intervention, the same three topographies as the training phase were targeted but with five target sentences containing four to eight CVC, CVCC, and/or sight words. Once the participant met criterion in the advanced phase, post-intervention conditioned seeing probes across three initial sets were conducted. If the participant did not demonstrate 5/5 correct responses across two probes, the participant returned to the advanced phase of the intervention with a novel set of sentences (Step 5, Figure 2). This process was continued until the participant demonstrated 5/5 correct responses across two initial probe sets (see Figure 2). If the participant did demonstrate 5/5 correct responses across two initial probe sets, then the researcher proceeded to conduct three additional conditioned seeing probes across three novel sets of stimuli.

Novel Conditioned Seeing Probes. Novel conditioned seeing probes were conducted in the same manner as pre-intervention conditioned seeing probes. The participants were required to demonstrate 11 out of 15 (70% accuracy) correct responses overall across the three novel probes. If the participant met criterion, the researcher conducted post-intervention probes for all remaining dependent variables in the same manner as pre-intervention probes.

If the participant did not demonstrate 11 out of 15 correct responses across two probes, the participant returned to the advanced phase of the intervention with a novel set of sentences. Once criterion for the additional advanced phase was met, conditioned seeing probes were conducted again with the same stimuli as novel probes. This process was repeated until the participant demonstrated 5/5 correct responses across two probe sets. If the participant did demonstrate 5/5 correct responses across two novel probe sets, then the researcher proceeded to conduct three additional conditioned seeing probes across an additional three novel set of stimuli. This process was repeated until the participant demonstrated 11 out of 15 correct responses across three novel sets of stimuli, which indicated the establishment of conditioned seeing.

3.1.7 Interobserver and Interscorer Agreement

Interobserver agreement (IOA) was collected through trial-by-trial agreement with a trained independent second observer. For conditioned seeing probes, IOA was conducted for 63.33% of sessions with an agreement of 100%. For Inc-BiN probes, IOA was conducted for 71.05% of sessions with a mean agreement of 99.63% (range 95% -100%). For read-draw probes, IOA was conducted for 89.47% of sessions with a mean agreement of 99.18% (range 73% -100%). For *WJIV®* subtests, IOA was conducted for 87.50% of sessions with a mean agreement of 99.71% (range 94% -100%). For conditioned reinforcement for books without pictures, IOA was conducted for 48.72% of sessions with a mean agreement of 95.79% (range 92% -100%). Lastly, for the training phase of intervention, IOA was conducted for 66.67% of sessions with a mean agreement of 99.63% (range 97% -100%) and for the advanced phase of intervention, IOA was conducted for 45.16% of sessions with an agreement of 100%.

To ensure accurate data analysis, a second stage of IOA corrected all disagreements across read-draw probes. A third, trained, and independent observer reviewed all probes with discrepancies and was asked to score the number of correct drawing components in each. The data from this third independent observer were used to settle the disagreements between the first two data collectors and led to 100% agreement for read-draw responses.

3.1.8 Treatment Fidelity

The Teacher Rate/Performance Accuracy (TPRA, Ingham & Greer, 1992) was used to measure treatment fidelity. The TPRA was administered by a second independent observer where the researcher's presentation of correct and unambiguous antecedents, participant responses, and the researcher's response to the participant's response was measured. Treatment fidelity was conducted for 44.19% of intervention sessions with a fidelity of 100%.

3.2 Results

All participants demonstrated the establishment of conditioned seeing after MEI across delayed selection and production responses (see Figure 6). Figure 3 displays results for read draw probes; Table 16 displays results for *WJIV*® Test 4 and Test 12; Figure 4 displays results for conditioned reinforcement for books without pictures; Figure 5 displays results for Inc-BiN; and Figure 6 displays results for conditioned seeing probes and intervention sessions.

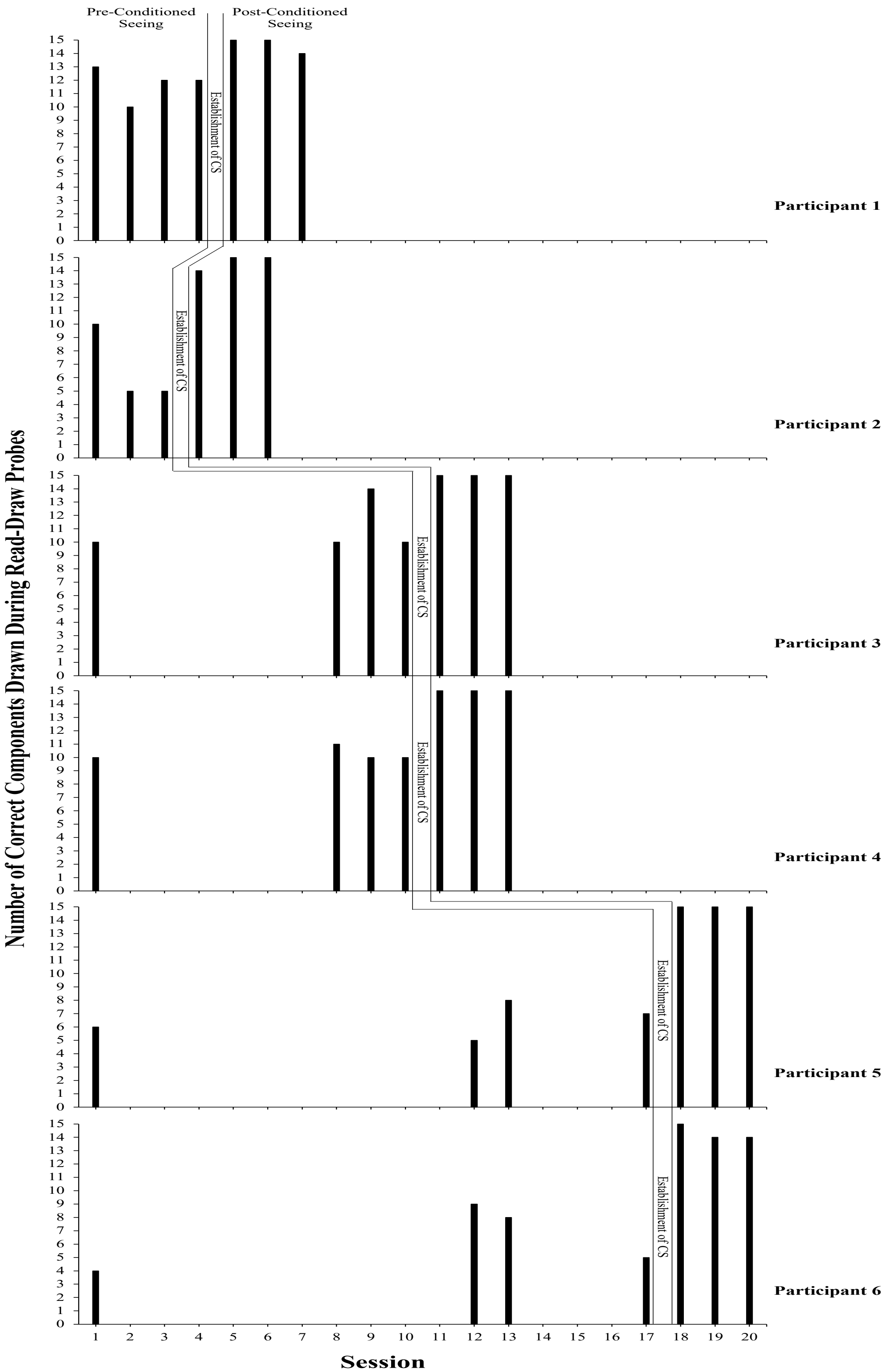
3.2.1 *Read-Draw*

Figure 3 demonstrates results for read-draw probes before and after the establishment of conditioned seeing. Across all participants, they emitted a mean of 9.62 correct drawing components out of 15 possible responses prior to the establishment of conditioned seeing, After the establishment of conditioned seeing, participants emitted a mean of 14.78 correct drawing components.

Participant 1-6 emitted a mean of 11.75, 6.67, 11, 10.25, 6.5, and 6.5, correct drawing responses across all pre-intervention probe sessions, respectively. Following the establishment of conditioned seeing via MEI across delayed selection and production responses, all participants demonstrated an increase in their accurate drawing responses. Participants 1-6 emitted a mean of 14.67, 14.67, 15, 15, 15, and 14.33 correct drawing responses, respectively. Five out of six participants demonstrated increases of at least four correct responses with Participant 2, 5, and 6 demonstrating the greatest increase.

Figure 3

The Effect of Conditioned Seeing on Read-Draw Responses



3.2.2 *WJIV®* *Reading Comprehension Cluster*

Table 16 displays results for *WJIV®* Test 4: Passage Comprehension and Test 12: Reading Recall before and after the establishment of conditioned seeing.

W Scores. Prior to the establishment of conditioned seeing, all participants emitted a mean W score of 444 for Test 4 and a mean W score of 457 for Test 12. After the establishment of conditioned seeing all participants demonstrated an increase in their W score for Test 4 and five out of six participants demonstrated an increased in their W score for Test 12. Participants 2, 3, 4 and 6 demonstrated the greatest increase for Test 4 whereas Participants 1, 2, and 4 demonstrated the greatest increase for Test 12.

Standard Scores. Prior to the establishment of conditioned seeing, all participants emitted a mean standard score of 103 for Test 4 and a mean standard score of 110 for Test 12. After the establishment of conditioned seeing all participants demonstrated an increase in their standard scores for Test 4 and five out of six participants demonstrated an increase in their standard scores for Test 12. Participant 2 demonstrated the greatest increase for Test 4 while Participants 1 and 4 demonstrated the greatest increase for Test 12.

Number of Correct Responses. Prior to the establishment of conditioned seeing, all participants emitted a mean of 13.5 correct responses for Test 4 and a mean of 1.5 correct responses for Test 14. After the establishment of conditioned seeing, participants emitted a mean number of correct responses increased to 17.17 correct responses for Test 4 and participants mean number of correct responses increased to 4.83 correct responses for Test 12. Participant 2 demonstrated the greatest increases for Test 4 while Participant 1 demonstrated the greatest increase for Test 12.

Table 16

Summary of WJIV ® Results for Test 4 and Test 12 Results Across Participants in Experiment 2

		W Score			Standard Score			Number Correct		Percentile Rank		Grade Level Equivalence	
		Comp	Recall	*M*	Comp	Recall	*M*	Comp	Recall	Comp	Recall	Comp	Recall
Participant 1	Pre	465	453	459	125	102	114	23	2	95	55	1.8	K.5
	Post	467	479	473	122	119	121	24	19	93	89	1.9	1.9
	Change	+2	+26	+14	-3	+17	+7	+1	+17	-2	+34	+0.3	+1.4
Participant 2	Pre	421	444	433	104	93	99	11	1	60	33	K.5	<K.0
	Post	450	459	455	114	104	109	19	3	83	62	1.3	K.8
	Change	+29	+15	+22	+10	+9	+10	+	+2	+23	+29	+0.8	+0.8
Participant 3	Pre	433	470	452	108	113	111	14	5	70	80	K.8	1.3
	Post	452	453	453	113	98	106	19	2	81	44	1.3	K.5
	Change	+19	-17	+1	+5	-15	-5	+5	-3	+11	-36	+0.5	-0.8
Participant 4	Pre	430	434	432	106	82	94	13	0	66	12	K.7	<K.0
	Post	441	453	447	108	98	103	16	2	69	44	1.0	K.5
	Change	+11	+19	+15	+2	+16	+9	+3	+2	+4	+32	+0.3	+0.5
Participant 5	Pre	411	434	423	95	81	88	9	0	37	11	K.3	<K.0
	Post	418	444	431	96	89	93	10	1	40	24	K.4	<K.0
	Change	+7	+10	+8	+1	+8	+5	+1	+1	+3	+13	+0.1	0
Participant 6	Pre	421	444	433	100	91	96	11	1	49	27	K.5	<K.0
	Post	437	453	445	105	98	102	15	2	64	44	K.9	K.5
	Change	+16	+9	+12	+5	+7	+6	+4	+1	+5	+17	+0.4	+0.5
M	Pre	430	457	444	103	94	99	13.5	1.5	-	-	-	-
	Post	444	457	451	110	101	106	17.17	4.83	-	-	-	-
	Change	+14	0	+7	+7	+7	+7	+3.67	+3.33	-	-	-	-

Note: Pre and Post refers to performance before and after the establishment of conditioned seeing.

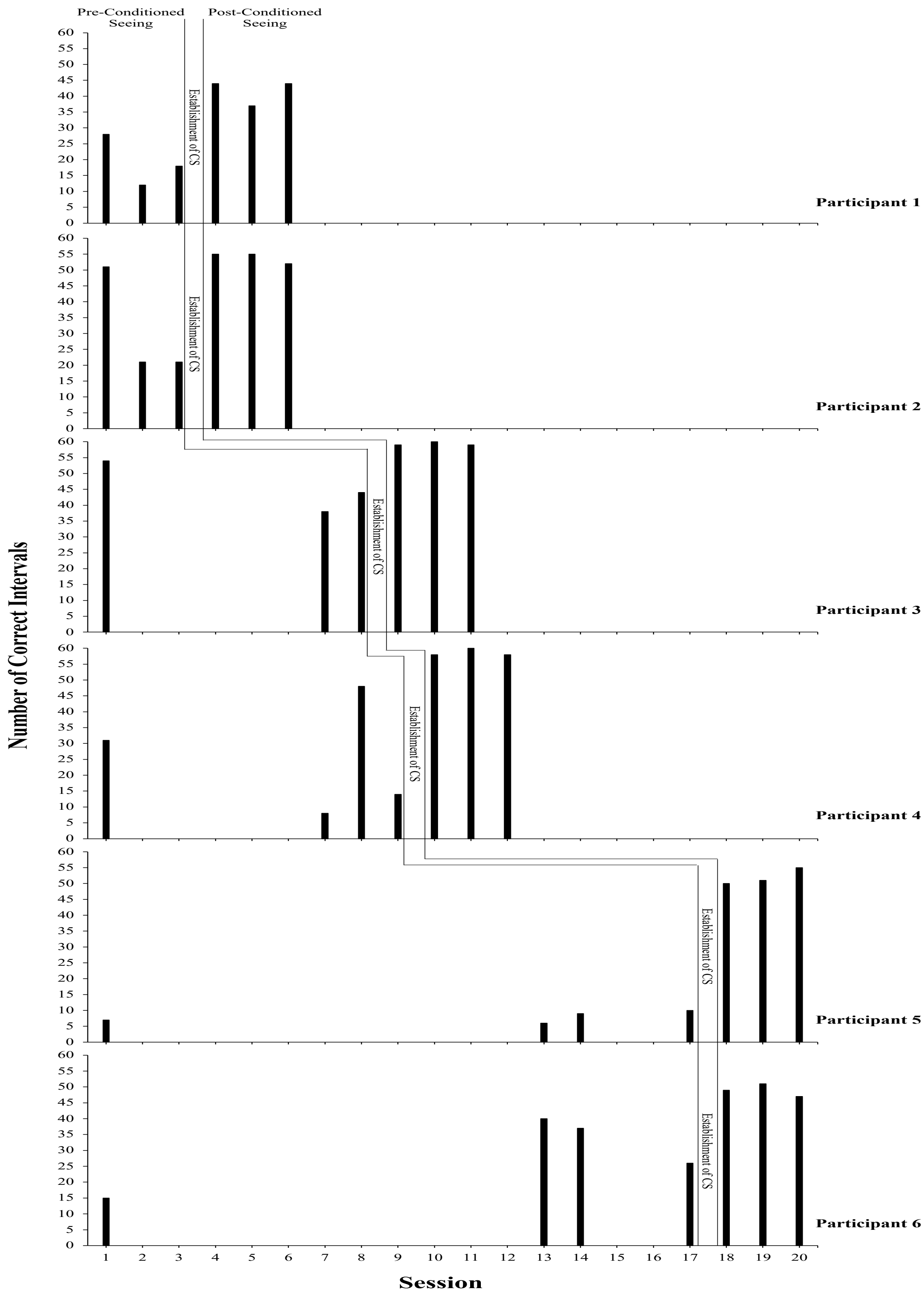
3.2.3 *Conditioned Reinforcement for Books without Pictures*

Figure 4 demonstrates results for conditioned reinforcement for observing books without pictures before and after the establishment of conditioned seeing. Prior to the establishment of conditioned seeing, all participants observed books without pictures for a mean duration of 128.1 s out of a possible of 300 s. After the establishment of conditioned seeing, participants observed books without pictures for a mean duration of 262.2 s.

Prior to the establishment of conditioned seeing, Participant 1-6 observed books without pictures for a mean duration of 100.33 s (range 60 s – 140 s), 155 s (range 105 s – 255 s), 216.65 s (range 190 s – 270 s), 125.25 s (range 40 s – 240 s), 40 s (range 30 s – 50 s), and 147.50 s (range 75 s – 200 s), respectively, across all pre-intervention probe sessions. After the establishment of conditioned seeing, all participants demonstrated an increase in duration for observing books without pictures during post-intervention probes. Participants 1-6 observed books without pictures books without pictures for a mean duration of 208.35 s (range 185 s – 220 s), 270 s (range 260 s – 275 s), 296.65 s (range 295 s – 300 s), 298.35 s (range 290 s – 300 s), 260 s (range 250 s – 275 s), and 245 s (range 235 s – 255 s), respectively. Participant 2, 4, and 6 demonstrated the greatest increase in reinforcement value for books following the establishment of conditioned seeing.

Figure 4

The Effect of Conditioned Seeing on Conditioned Reinforcement for Books without Pictures



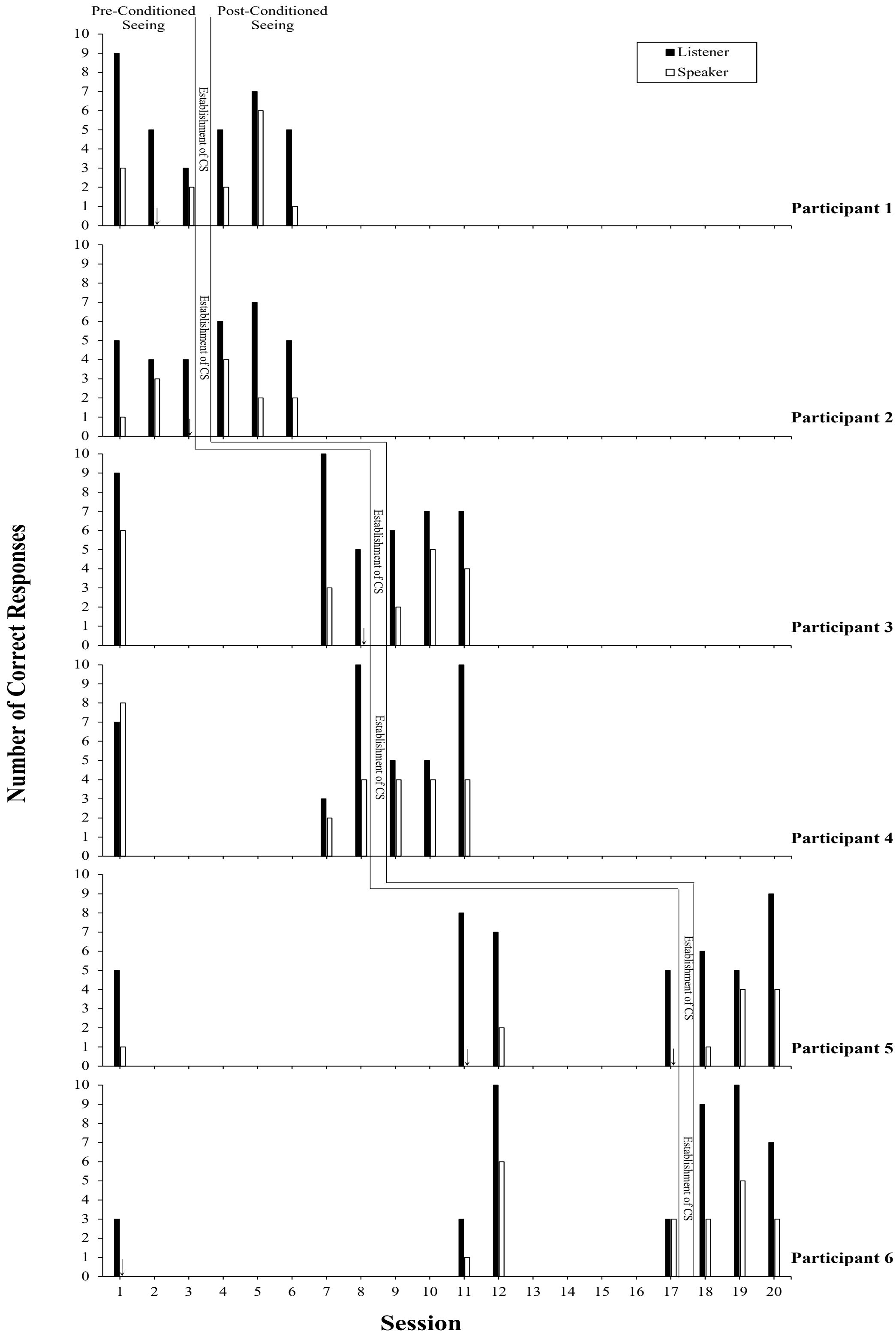
3.2.4 *Inc-BiN*

Figure 5 demonstrates results for Inc-BiN before and after the establishment of conditioned seeing. Prior to the establishment of conditioned seeing, all participants emitted a mean of 5.9 correct untaught listener responses out of 10 and 2.25 correct untaught speaker responses out of 10. After the establishment of conditioned seeing, all participants emitted a mean of 6.72 correct untaught listener responses and 3.33 correct untaught speaker responses.

During initial Inc-BiN probes, Participants 1-6 emitted a mean of 5.67, 4.33, 8, 6.67, 6.25, and 4.75 correct untaught listener responses, respectively, and a mean of 1.67, 1.33, 3, 4.67, 0.75, and 2.50 correct untaught speaker responses, respectively. Post-intervention Inc-BiN probes demonstrate variable effects from the establishment of conditioned seeing. Participants 2, 5, and 6 demonstrated slight increases in their mean number of correct untaught listener responses, whereas Participants 1, 2, 3, 5, and 6 demonstrated slight increases in their mean number of correct speaker responses.

Figure 5

The Effect of Conditioned Seeing on Incidental Bidirectional Naming



3.2.5 *Establishment of Conditioned Seeing*

Lastly, Figure 6 demonstrates the effects of the MEI intervention across delayed selection and production responses on the establishment of conditioned seeing. Across all participants, they required a mean of 7 (range 5-9) intervention sessions to establish conditioned seeing. Results for each dyad will be discussed subsequently.

Dyad 1. Prior to the intervention, conditioned seeing responses for Participant 1 and Participant 2 had a mean of 1.33 correct responses. After the training phase of the intervention, Participant 1 and Participant 2 did not demonstrate 5 out of 5 correct responses in their first post-intervention probe, thus they continued onto the advanced phase. Following the advanced phase with their first sentence set, both participants emitted more accurate matching responses, but not at criterion level. After returning to the advanced phase with an additional sentence set, Participant 1 demonstrated criterion level matching responses for his initial sets and three novel sets, which indicated the establishment conditioned seeing. For Participant 2, a third advanced intervention phase was required with an additional sentence set, after which she demonstrated the establishment of conditioned seeing across initial and novel probes. Participant 1 required five intervention sessions while Participant 2 required 10 intervention sessions to demonstrate the establishment of conditioned seeing.

Dyad 2. In baseline phase, Participant 3 had a mean of 0.33 correct responses and Participant 4 had a mean of 1.67 correct responses for conditioned seeing. After the training phase, Participant 3 and Participant 4 did not demonstrate 5 out of 5 correct responses in their first post-intervention probe, thus they continued onto the advanced phase. Following the advanced phase with their first sentence set, both participants demonstrated an increase in accurate matching responses. Participant 3 did not demonstrate a criterion level of conditioned seeing following the advanced phase, thus returned to this phase of intervention with an additional sentence set. Following an additional session of intervention, Participant 3 decreased in accurate responding. Since Participant 3 was meeting criterion for each intervention phase in one session, the researcher increased her exposure in Phase B of the advanced phase (see Figure 2). Following Phase B, Participant 3 demonstrated the establishment of conditioned seeing across initial probe sets and novel probe sets.

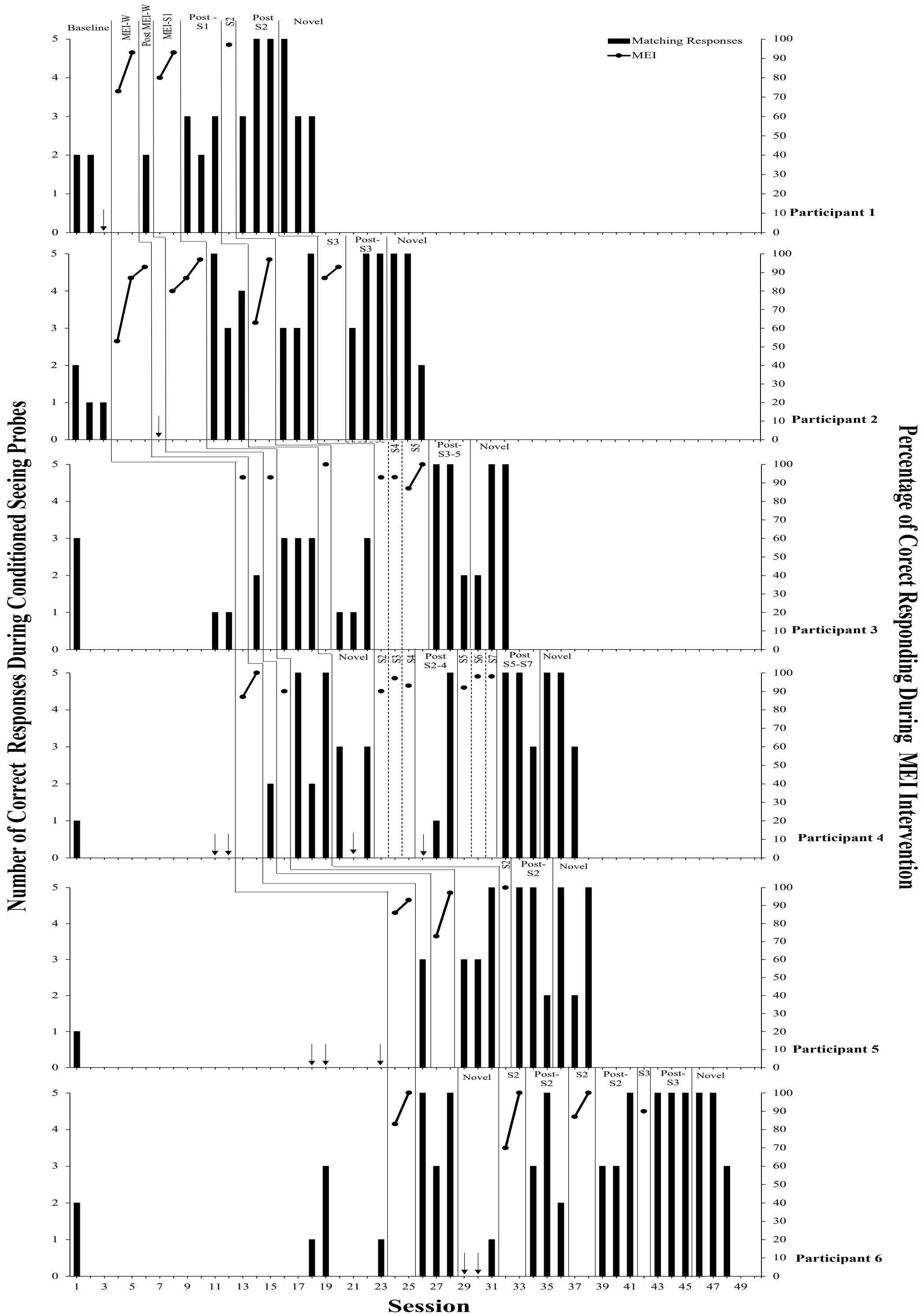
Unlike Participant 3, Participant 4 did demonstrate a criterion level of conditioned seeing across her initial probe sets following the advanced phase of intervention, thus proceeded onto novel conditioned seeing probes. After conducting three novel probes, Participant 4 did not meet criterion for novel probes and returned to the advanced phase of intervention. Like Participant 3, the researcher increased Participant 4's exposure to the intervention by conducting Phase B of the advanced phase of intervention. Following this, post-probes for conditioned seeing were conducted with the same sets as the novel probe phase. Participant 4's number of correct responses during the first probe with Set 2 remained the same, while her correct responses during the second probe demonstrated a slight decrease for Set 7; however, Participant 4 did demonstrate 5 out of 5 correct responses for Set 1. To further increase exposure to the intervention, the researcher then conducted Phase C of the advanced phase (see Figure 2). Following Phase C of intervention, Participant 4 demonstrated criterion level of conditioned seeing across Sets 2, 7, and 1 and criterion level across three novel probes demonstrating the establishment of conditioned seeing.

Dyad 3. Like Dyads 1 and 2, the accuracy of conditioned seeing responses for Participant 5 and Participant 6 were initially low. Participant 5 had a mean of 0.25 correct responses and Participant 6 had a mean of 1.75 correct responses across four pre-intervention probes. Following the training phase of intervention, both participants demonstrated an increase in the number of correct responses across one probe. Participant 5, however, did not achieve 5/5 correct responses, thus he proceeded onto the advanced phase of intervention after his first post probe. Conditioned seeing probes conducted after the advanced phase of intervention demonstrate that there was an increase in correct matching responses, however not to criterion, thus Participant 5 returned to the advanced phase of intervention for a novel set of sentences. Following the second phase of the advanced phase, Participant 5 demonstrated criterion for his initial probe sets as he demonstrated mastery of two initial probe sets and demonstrated criterion level of responding across three novel probes.

Unlike Participant 5, Participant 6 demonstrated 5 out of 5 correct responses in his first post-intervention probe, thus two additional conditioned seeing probes were conducted. Participant 6 demonstrated mastery of two initial probe sets after which, three novel probes were conducted. Participant 6 did not meet criterion level for conditioned seeing across three novel sets, thus he commenced the advanced phase of the intervention. Following the advanced phase, post-probes for conditioned seeing were conducted with the same sets as the novel probe phase. Participant 6 demonstrated an increase of 3 correct responses for Set 4 and an increase of 5 correct responses for Set 7 and an increase of 1 correct response for Set 6. Because criterion level was not met, an additional phase of the advanced phase of the intervention was conducted. Following this additional phase, Participant 6 demonstrated mastery of all sets and achieved criterion level across three novel conditioned seeing probes.

Figure 6

The Effect of MEI across Delayed Selection and Production Responses on the Establishment of Conditioned Seeing



3.3 Discussion

Results demonstrate the effects of the establishment of conditioned seeing on reading comprehension, conditioned reinforcement for observing books without pictures, and Inc-BiN for six kindergarten students with and without disabilities. The most significant findings were in relation to reading comprehension and conditioned reinforcement for observing books without pictures. Results also demonstrate that the MEI across pictures and words intervention was effective in establishing conditioned seeing for six kindergarten students with and without disabilities.

3.3.1 Read-Draw and *WJIV*® Reading Comprehension Cluster

Read-draw probes measured participants' literal comprehension of a sentence. Results across dyads demonstrate that the establishment of conditioned seeing functioned to also improve literal reading comprehension. Initially, all participants demonstrated some reading comprehension for sentences as evidenced by their accurate drawing responses during baseline probes. This is consistent with initial baseline levels of conditioned seeing as results indicated that all participants had some stimulus control for conditioned seeing, which can explain their initial accurate drawing responses. Once conditioned seeing was established to criterion level, all participants demonstrated improved reading comprehension as evidenced by higher accurate drawing responses. These findings suggest that establishing conditioned seeing also improved participants' reader-as-own listener repertoire such that they could listen to their own textual responses to evoke a covert visual image. This is evident as all participants demonstrated higher accurate drawing responses during post-intervention probes, which were facilitated by their conditioned seeing repertoire.

All participants demonstrated an increase in their number of correct responses and W score for Test 4: Passage Comprehension. In Test 4, participants were asked to vocally identify a missing word for a printed sentence after reading the sentence silently. The increases number of correct responses and W scores for Test 4 corroborate with previous findings for read-draw probes, supporting that the establishment of conditioned seeing functioned to improve participants' reader-as-own listener repertoire. The establishment of conditioned seeing allowed participants to better listen to their covert textual responses such that they can accurately identify a missing word. Previous literature on silent reading suggests that silent reading is a higher-level reader skill that needs to be taught (Hill-Powell, 2015), therefore, when participants were asked to covertly read each sentence from Test 4, their missing instructional history for silent reading could have limited their reading comprehension and score increases.

Furthermore, the more accurate responses participants emitted during Test 4, the longer and more complex the sentences got. Given that participants' instructional history for reading is not extensive, as they all began to read this school year, most participants were limited in the number of sentences they could textually respond to; it is possible that participants' missing instructional history for complex word patterns and sight words interfered with their reading comprehension explaining why increases in accurate responses were limited. Nonetheless, results from Test 4 suggest that conditioned seeing functioned to improve participants' reader-as-own listener repertoire such that they could emit higher accurate responses.

Five out of six participants demonstrated an increase in their number of correct responses and W score for Test 12: Reading Recall. Like Test 4, Test 12 required participants to silently read a short passage. Once participants read a given passage, they were instructed to recall anything from the passage they could remember. As previously mentioned, silent reading is a higher-level reader, therefore, when participants were asked to covertly read passages, their missing instructional history for silent reading could have limited their recall ability during Test 12. Participants' missing instructional history for complex word patterns and sight words may also have interfered as passages contained words that were unfamiliar to most of the participants. Despite this, the increases for five participants provide further evidence that the establishment of conditioned seeing did function to improve participants' reader-as-own-listener repertoires as they recalled a more features than when conditioned seeing was not established.

3.3.2 Conditioned Reinforcement for Books without Pictures

Results indicate that prior to the establishment of conditioned seeing, participants had little and variable reinforcement value for observing books without pictures. Dyad 1 and Participant 5 demonstrated stable but low reinforcement value for observing books without pictures prior to the establishment of conditioned seeing. Post-intervention results demonstrate that the reinforcement value of observing books without pictures increased following the establishment of conditioned seeing.

The reinforcement values of observing books without pictures for Dyad 2 were initially higher than Dyad 1, however this reinforcement value was inconsistent as their baseline levels were variable. A similar trend was observed for Participant 6: he demonstrated variability during pre-intervention probes, therefore demonstrating that the reinforcement value for observing books without pictures was also inconsistent. Results following the establishment of conditioned seeing demonstrate how the reinforcement value of observing books without pictures increased following the establishment of conditioned seeing and that this reinforcement value was consistent across all post-intervention probes.

It is hypothesized that the increases in reinforcement value for observing books without pictures was possible because of the establishment of conditioned seeing. Prior to the establishment of conditioned seeing, it can be argued that participants emitted some level of visualization while observing books without pictures resulting in a low mean in duration for observation. After the establishment of conditioned seeing, it can be argued that participants emitted higher levels of visualizations while observing books. Further, it is possible that these covert visualizations functioned to condition the printed text in books such that participants continued to observe the book despite the absence of pictures. These results further support how the establishment of conditioned seeing functioned to further establish participants' reader-own-listener repertoire since they had to rely on this repertoire to produce visualizations of the printed text, which in turn, increased the reinforcement value of books without pictures.

3.3.3 Inc-BiN

Results show that three of the six participants demonstrated slight increases in Inc-BiN following the establishment of conditioned seeing, however this effect is not strong. There was a slightly stronger effect observed for untaught speaker responses than untaught listener responses, which suggests that establishing conditioned seeing may have facilitated a small effect on their joining of listener and speaker repertoires. With the establishment of conditioned seeing, participants have increased their production repertoire as they are more likely to produce visualizations, therefore, it could be that this increase in participants' production repertoire facilitated the emergence of few untaught speaker responses. Nonetheless, previous literature and results from Experiment 1 suggest that conditioned seeing is an extension of the listener repertoire, which brings into question whether the establishment of Inc-UniN *only* leads to increases in conditioned seeing responses. If so, it may be that following the emergence of Inc-UniN, conditioned seeing may also emerge.

The remaining three participants demonstrated either no increases or slight decreases in Inc-BiN following the establishment of conditioned seeing. Although it is observed across reading comprehension measures that the establishment of conditioned seeing further established the reader-as-own-listener repertoire, the minimal effect seen across Inc-BiN results suggest that this change was not sufficient to join the speaker-as-own-listener repertoire, which would be evident by the establishment of Inc-BiN. Typically, MEI interventions that establish Inc-BiN require numerous sessions of intervention, thus one possible explanation for why MEI across delayed selection and production responses did not establish Inc-BiN is that participants did not have enough exposure to the intervention. Furthermore, MEI interventions that establish Inc-BiN consist of the rotation of listener (i.e., match and point-to) and speaker responses (i.e., intraverbal and tact) and given that this intervention did not include speaker responses for most of the participants, it could be that the topographies trained during intervention were insufficient to join the listener and speaker repertoire. Future replications of this study should include speaker responses as done in Phase C of the advanced phase to determine whether the rotation across delayed selection, production (i.e., drawing), and speaker topographies can establish Inc-BiN.

Nonetheless, research demonstrates that Inc-BiN for familiar stimuli emerges prior to Inc-BiN for unfamiliar stimuli, which may suggest that the establishment of conditioned seeing may be functionally related to Inc-BiN for familiar stimuli but not unfamiliar stimuli. Future research should include measures for Inc-BiN for familiar stimuli to determine if it is functionally related to conditioned seeing. Despite the minimal effect, the absence of a functional relationship between the establishment of conditioned seeing and the establishment of Inc-BiN for unfamiliar stimuli does not rule out whether the establishment of Inc-BiN for unfamiliar stimuli will result in the establishment of conditioned seeing in kindergarten students, thus more research is needed.

3.3.4 Establishment of Conditioned Seeing

Results across all dyads demonstrate that the MEI across delayed selection and production responses was effective in establishing conditioned seeing in kindergarten students. This extends the work of Hwang-Nesbit (2021), who demonstrated that Inc-BiN could be established using curriculum. When compared to previous literature on conditioned seeing, these results support Mercorella's findings in that using a reading-based intervention not only teaches students more complex reader behaviors, but that it can also be beneficial to establish other verbal behavior cusps, such as conditioned seeing.

Though all participants did have to return to the advanced phase at least twice, the consistent overall increases following each intervention phase demonstrate that the rotation of delayed selection and drawing responses does function to establish conditioned seeing. This suggests that teaching students how to select matching pictures for printed text, how to select matching sentences for pictures, and how to draw matching pictures for printed text should be incorporated in reading instruction as it functioned to better improve all participants' reading comprehension.

The additional intervention sessions that were required to establish conditioned seeing suggest that participants needed increased exposure to the rotation of the listener and drawing responses, which further suggests that the integration of listener responses and drawing responses should be across multiple domains of reading instruction to provide students with additional exposure. Furthermore, the establishment of conditioned seeing for early readers suggests that conditioned seeing is a cusp that can emerge early in one's life and early in one's reader repertoire. This is beneficial in that students can learn to visualize the printed text and learn how to read simultaneously without waiting for formal instruction in reading comprehension to begin.

Results from this experiment call into question whether the behavior of drawing is an extension of the listener repertoire or speaker repertoire? I argue that drawing is an extension of both repertoires as both appear to be necessary to produce drawing responses. For example, if a student is asked to draw a house, they may emit speaker behavior such as "Next, the house needs a window, a door, and a roof." The student would have to listen to their self-talk behavior while drawing and once the drawing is complete, the student must engage in a different form of listening behavior as they observe their completed drawing to determine if it is indeed complete or if more details are needed.

Chapter 4: General Discussion

In two experiments, I investigated the role of conditioned seeing on incidental bidirectional naming (Inc-BiN) for unfamiliar stimuli and reading achievement. The study contributes to previous literature which suggested that Inc-BiN and conditioned seeing are important in reading comprehension in older readers (Shanman, 2013; Mercorella, 2017; Syed, 2018; Baldonado, 2021; Hwang, 2021). In Experiment 1, I investigated the correlation, associations, and differences between conditioned seeing, Inc-BiN, and measures of reading achievement for 49 participants in kindergarten through second grade. Participants' stimulus control for conditioned seeing was significantly correlated with participants' stimulus control for Inc-BiN and with participants' scores and performance percentiles on the *iReady® K-12 Adaptive Reading* diagnostic (Curriculum Associates, LLC, 2017). Group differences across participants with low stimulus control for conditioned seeing and high stimulus control for conditioned seeing show that students with a high stimulus control for conditioned seeing achieved higher means across Inc-BiN, overall *iReady*® reading scores, literature comprehension scores, and informational comprehension scores. Results from Experiment 1 replicate previous literature, which showed that participants' stimulus control for conditioned seeing is correlated with Inc-BiN and reading comprehension (Shanman, 2013; Mercorella, 2017; Syed, 2018).

Experiment 1 established the need to further investigate conditioned seeing and its effects on reading performance and Inc-BiN for students in kindergarten through second grade. In Experiment 2, I investigated the effects of MEI across a delayed selection and production responses intervention on the establishment of conditioned seeing for six kindergarten students with and without disabilities. During intervention, three topographies were targeted. First, participants textually responded to CVC words or sentences and emitted delayed selection responses for the corresponding pictures. Next, participants observed pictures and emitted delayed selection responses for the corresponding CVC word or sentence. Lastly, participants textually responded to CVC words or sentences and emitted delayed production responses (i.e., drawing) for the corresponding CVC word or sentence. Results demonstrate that MEI across delayed selection and production responses was effective in establishing conditioned seeing for all participants.

Furthermore, I investigated the effects of the establishment of conditioned seeing on reading comprehension, conditioned reinforcement for books without pictures, and Inc-BiN. Results show that the establishment of conditioned seeing is functionally related to reading comprehension as evidenced by increases in read-draw responses and scores for *WJIV*® reading comprehension tests. Results further show that the establishment of conditioned seeing resulted in increases in the reinforcement value for books without pictures as evidenced by an increased duration for observing books without pictures. Variable results were found for the effects of the establishment of conditioned seeing on Inc-BiN where three out of six participants demonstrated slight increases in Inc-BiN stimulus control.

4.1 Major Findings

4.1.1 Reading Comprehension

Skinner (1957) described that conditioned seeing responses can occur within one's skin while reading, meaning that as the reader is emitting textual responses to printed text, listening to their textual responses evokes covert conditioned seeing responses such that the reader can "see" what is being described as a function of conditioned seeing. Conditioned seeing is then defined as seeing or hearing stimuli that are not present in the physical environment but are rather described in the text (Skinner, 1957). When a reader describes "seeing" or "hearing" stimuli he or she may do so because of conditioned (i.e., paired) stimulus-stimulus relations (e.g., printed word-picture, picture-vocal word etc.). If a reader emits conditioned seeing responses while reading, it is then concluded that the reader has comprehended the printed words.

This study demonstrated that the establishment of conditioned seeing can improve participants' reading comprehension. Prior to the establishment of conditioned seeing, all participants emitted fewer than 15 correct components in their drawing responses during pre-intervention read-draw probes, indicating that they had a limited comprehension of what each sentence was describing. Following the establishment of conditioned seeing, all participants included more correct components in their drawing responses during post-intervention read-draw probes indicating that their reading comprehension improved. Previous literature demonstrated that the reader-as-own-listener repertoire is crucial for proficient reading comprehension (Hill-

Powel, 2015; Mercorella, 2017). It is hypothesized that the MEI across delayed selection and production responses functioned to teach students how to listen to their textual responses, meaning that it functioned to further develop their reader-as-own-listener repertoire. Results across the *WJIV®* reading comprehension tests provide additional empirical evidence for this hypothesis as all participants' passage comprehension increased and five out of six participants' reading recall increased following the establishment of conditioned seeing. Therefore, conditioned seeing functions to improve reading comprehension since it allows for the development of the reader-as-own-listener repertoire.

From these results, the role of vocabulary comes into question as participants must have a previously printed word-to-visual relation to successfully produce accurate selection responses during intervention and accurate responses during reading comprehension measures. For example, given the printed word *ram*, the participants could only accurately produce an accurate selection response during intervention and an accurate correct response during reading comprehension probes if the word *ram* was in the participant's repertoire with a matching visual stimulus. In other words, the word *ram* must have been in the participant's vocabulary repertoire. From this, it can be argued that an adequate vocabulary repertoire is a necessary pre-requisite to conditioned seeing.

Results from Experiment 1 provide additional empirical evidence for how conditioned seeing is related to the reader-as-own-listener repertoire. Skinner (1957) considered reading an extension of the listener repertoire since readers must "listen" to their textual responses to facilitate reading comprehension. Correlation analyses reveal that participants' stimulus control for conditioned seeing has a greater correlation with their stimulus control for untaught listener responses than untaught speaker responses, providing evidence that conditioned seeing is related to their listener repertoire, which directly affects their reader-as-own-listener repertoire. Participants' stimulus control for conditioned seeing was consistently significantly correlated with participants' scores for literature comprehension and informational comprehension across Winter and Spring reading diagnostics. The correlations between conditioned seeing and reading comprehension were the strongest out of all variables assessed, highlighting how conditioned seeing is related to the reader-as-own listener repertoire for students in kindergarten through second grade. Moreover, results across groups with a low stimulus control for conditioned seeing and high stimulus control for conditioned seeing demonstrate that a higher stimulus control for conditioned seeing functions to improve participants' reading comprehension for literature and informational texts.

4.1.2 Conditioned Reinforcement for Books without Pictures

Results from Experiment 2 demonstrate how the establishment of conditioned seeing also functioned to increase participants' reinforcement value for books without pictures. This finding is highly important as previous literature demonstrated that third-grade students performing below grade level in reading have significantly lower reading comprehension scores when reading texts without pictures than when reading texts with pictures (Mercorella, 2017). Given that the initial reinforcement value for books without pictures was initially low for five out of six participants prior to the establishment of conditioned seeing, it demonstrates that conditioning text without pictures is an important step in mitigating future reading comprehension difficulties. Participants conditioned seeing repertoire not only functions to condition text without pictures, but it is also possible that it functions as an abolishing operation for visual stimuli during reading.

Once conditioned seeing was established for all participants, their reinforcement value for books without pictures increased such that they observed books without pictures for a longer duration across all post-intervention probes. Therefore, the reinforcement value for books without pictures increased as a function of conditioned seeing. The MEI across delayed selection and production responses functioned to teach participants how to have covert conditioned seeing responses after textually responding to print. It is hypothesized that during post-intervention probes for conditioned reinforcement for books without pictures, participants emitted covert conditioned seeing responses after textually responding to the printed text, which reinforced their observing responses. Covert conditioned seeing responses functioned to condition books without pictures, which is critical as students' progress to read more complex text without pictures in school.

4.1.3 Inc-BiN

Results from Experiment 1 demonstrate that participants' stimulus control for conditioned seeing is significantly correlated with participants' stimulus control for Inc-BiN for unfamiliar stimuli. These results replicate previous literature's findings that show that conditioned seeing and Inc-BiN are significantly correlated (Shanman, 2013; Mercorella, 2017; Syed, 2018) for students in 2nd through 4th grade. Experiment 1's findings also extend previous findings to include younger students in grades kindergarten and first grade, suggesting that the relation between conditioned seeing and Inc-BiN is significant at an early age. Results also replicated previous literature which demonstrated that a stronger stimulus control for conditioned seeing indicated a stronger stimulus control for Inc-BiN (Shanman, 2013; Mercorella, 2017; Syed, 2018). Significant group differences from Experiment 1 demonstrate that students with a higher stimulus control for conditioned seeing indicates a higher stimulus control for Inc-BiN.

These results provide additional empirical support that conditioned seeing and Inc-BiN for unfamiliar are related in students as young as kindergarten age.

The effects of the establishment of conditioned seeing on Inc-BiN were slight and variable. Experiment 2 demonstrated that three of the six participants demonstrated slight increases in Inc-BiN following the establishment of conditioned seeing, whereas the remaining participants demonstrated an increase in stimulus control for either Inc-UniN or Inc-BiN, but not both, and/or they demonstrated decreases in their stimulus control for Inc-BiN. Despite the absence of a functional relationship between the establishment of conditioned seeing and the establishment of Inc-BiN, results call into question whether a higher stimulus control for Inc-BiN would result in a higher stimulus control for conditioned seeing in kindergarten students. It is possible that a higher stimulus control for Inc-BiN in kindergarten students could result in the establishment of conditioned seeing as seen in Syed (2018).

4.2 Limitations and Future Research

4.2.1 Experiment 1

In Experiment 1, conditioned seeing probes were conducted immediately after probes for Inc-BiN using the same unfamiliar stimuli. This is a limitation since participants' exposure to the target stimuli increased during Inc-BiN probes, which could have skewed their accuracy in drawing responses. Since participants' stimulus control for conditioned seeing was measured by drawing responses, their fine motor repertoire may have affected the accuracy in their drawing responses and further affected the measurement of correct and incorrect responses for drawings results as drawing responses naturally elicit experimenter subjectivity. These limitations were addressed in Experiment 2, where conditioned seeing probes were conducted independent of Inc-BiN probes and responses were measured by selection responses.

To further address these limitations in Experiment 1, future studies should continue to measure conditioned seeing responses independent of Inc-BiN and its measurement should be objective. Nonetheless, the differences across the two measurements for conditioned seeing included in this study suggest that future research is on various measurement procedures is warranted. Future research should compare drawing and selection measurement procedures with other measurement procedures to determine which is the most effective measurement for conditioned seeing. Additionally, future research should include conditioned seeing responses and Inc-BiN responses for novel familiar stimuli (e.g., flowers, landmarks, birds, etc.) to determine whether the stimulus control for conditioned seeing for familiar stimuli is also correlated with Inc-BiN for familiar and unfamiliar stimuli as well as measures of reading achievement.

For group differences, participants were grouped based on their number of correct drawing responses during conditioned seeing probes. Participants with 0 to 7 correct responses were considered to have low stimulus control for conditioned seeing, whereas participants with 8 to 15 correct drawing responses were considered to have a high stimulus control for conditioned seeing. Grouping participants in this way is a limitation since 10 of the 49 participants achieved 7 or 8 correct drawing responses, which border the cutoff scores for low versus high stimulus control for conditioned seeing and having a dichotomy will affect the degree of significant differences. Future research should include participants with a greater range of stimulus control for conditioned seeing such that more than two groups can be compared (e.g., low, medium, high stimulus control).

Although significant correlations were found between participants' stimulus control for conditioned seeing, Inc-BiN, and reading achievement, the R^2 values for each significant correlation do not account for all the variance in the data. It is hypothesized that moderating variables such as participants' existing cusps and capabilities as well as participants' reader skills in repertoire account for the remaining variance in data. To address this limitation, future research should account for such moderating variables or include participants with similar levels of verbal behavior and similar skill levels in reading to determine additional correlations between conditioned seeing, Inc-BiN, and reading achievement. It is possible that a more homogenous participant sample demonstrates greater correlations and greater R^2 values.

4.2.2 Experiment 2

In Experiment 2, the probe procedure for conditioned seeing addressed limitations from Experiment 1. Despite this, some limitations remain. The first limitation is a ceiling effect in the number of correct responses participants could achieve since each probe was out of five possible correct responses. This ceiling effect can also be observed since participants were limited in the number of correct responses they could achieve after one or more incorrect responses. For example, if a participant correctly selected the picture for three unfamiliar CVC words and their fourth selection response was incorrect, it automatically made their fifth response incorrect. Conversely, it is possible that some participants emitted more correct responses via exclusion. If participants successfully identified the corresponding symbol for four CVC words, their last selection response was automatically correct as participants excluded all other possibilities regardless of whether the CVC word evoked a covert conditioned seeing response. To address these limitations, future research should control for this ceiling effect by measuring selection responses independent of one another or by including more opportunities to select the corresponding symbol. Lastly, the differences in measurement procedures for conditioned seeing across both experiments suggests that both studies should be replicated using a consistent measurement procedure to better determine the effects of conditioned seeing on Inc-BiN and reading achievement.

As previously mentioned, probes for conditioned seeing were conducted independent of Inc-BiN probe, which increased the number of novel stimuli participants were exposed to. This is a possible limitation as participants' number of correct untaught listener and untaught speaker responses could have been affected by their interfering instructional histories with other unfamiliar stimuli that resembled the target stimuli during Inc-BiN probes. Participants' interfering instructional history with other stimuli are a result of conducting six conditioned seeing probes (i.e., three probes with initial sets and three probes with novel sets) prior to conducting post-conditioned seeing Inc-BiN probes. During conditioned seeing probes post-intervention, participants were exposed to six sets of unfamiliar stimuli (i.e., 30 unfamiliar stimuli), which may have interfered with their ability to incidentally learn additional stimuli during Inc-BiN probes. Future research should increase the latency between conducting post-intervention conditioned seeing probes and Inc-BiN probes to control for this limitation.

Lastly, only one participant was exposed Phase C of the advanced phase, which required the participant to vocally produce a sentence after observing a picture. The inclusion of this additional topography resulted in the establishment of conditioned seeing for this participant, whereas intervention sessions without it did not. Future replications of Experiment 2 should incorporate the vocal production of a sentence after observing a picture for all participants to determine whether conditioned seeing is established faster with this procedure. Furthermore, the inclusion of this additional topography could also function to join the listener and speaker repertoires such that Inc-BiN is established.

4.3 Educational Implications

Experiment 2 results show how the establishment of conditioned seeing resulted in educationally significant increases in reading comprehension and conditioned reinforcement for books without pictures. These results imply that educators should create an educational environment that teaches students how to emit covert conditioned seeing responses after reading text. Incorporating conditioned seeing in reading instruction should begin as soon as students begin to read, implying that educators can maximize the use of early reader instructional materials. In the younger grade levels, instructional stimuli for reading such as books and worksheets, often include many visuals that correspond to the printed text. Educators can maximize the use of such stimuli by teaching the stimulus-stimulus (i.e., word-to-picture, spoken-word-to-printed word, spoken-word-to-picture) relations they depict such that conditioned seeing responses emerge in the absence of visuals. Including conditioned seeing responses in reading instruction may eliminate the possibility of any future reading comprehension difficulties students may experience. In this way, this study differs from other reading studies as most reading interventions are idiosyncratic to reading problems, whereas procedures to establish conditioned seeing can also be incorporated as children learn to read.

The establishment of conditioned seeing functioned to increase the reinforcement value for books without pictures for all participants, which has great educational implications. Mercorella (2017) showed that students performing below grade-level in reading had significantly lower comprehension scores for texts without pictures than students performing at or above grade-level in reading. Mercorella (2017) also showed that students performing below grade-level in reading had significantly lower comprehension scores for texts without pictures than texts with pictures. These results indicate that students performing below grade-level rely on visuals to facilitate reading comprehension. Therefore, educators should establish conditioned seeing in students, especially those students performing below grade-level, such that they can read text without pictures with comprehension. By establishing conditioned seeing in students, it eliminates the function of visuals in text since the visuals can occur within the skin as a function of conditioned seeing. If this is done, educators can primarily use texts without pictures regardless of grade-level to provide students with multiple opportunities to emit conditioned seeing responses.

Conclusion

Across two experiments, I investigated the role of conditioned seeing on Inc-BiN and reading performance for students in kindergarten through second grade. Experiment 1 showed that the stimulus control for conditioned seeing is significantly correlated with Inc-BiN and reading performance, which indicated that conditioned seeing is related to the reader-as-own-listener repertoire. Additional evidence for this relation includes group differences, which demonstrated that a stronger stimulus control for conditioned seeing resulted in higher scores for reading comprehension. Experiment 2 showed that the establishment of conditioned seeing is functionally related to reading comprehension and conditioned reinforcement for books without pictures demonstrating that conditioned seeing is critical to students' reader repertoires. Currently, more than half of the United States' 4^{th} and 8^{th} graders are performing below grade level in reading (National Assessment of Education Progress, 2019) highlighting the need to revise current reading instructional practices. Conditioned seeing may be the necessary repertoire needed to improve reading pedagogy such that students can read any text with comprehension to further facilitate life-long learning.

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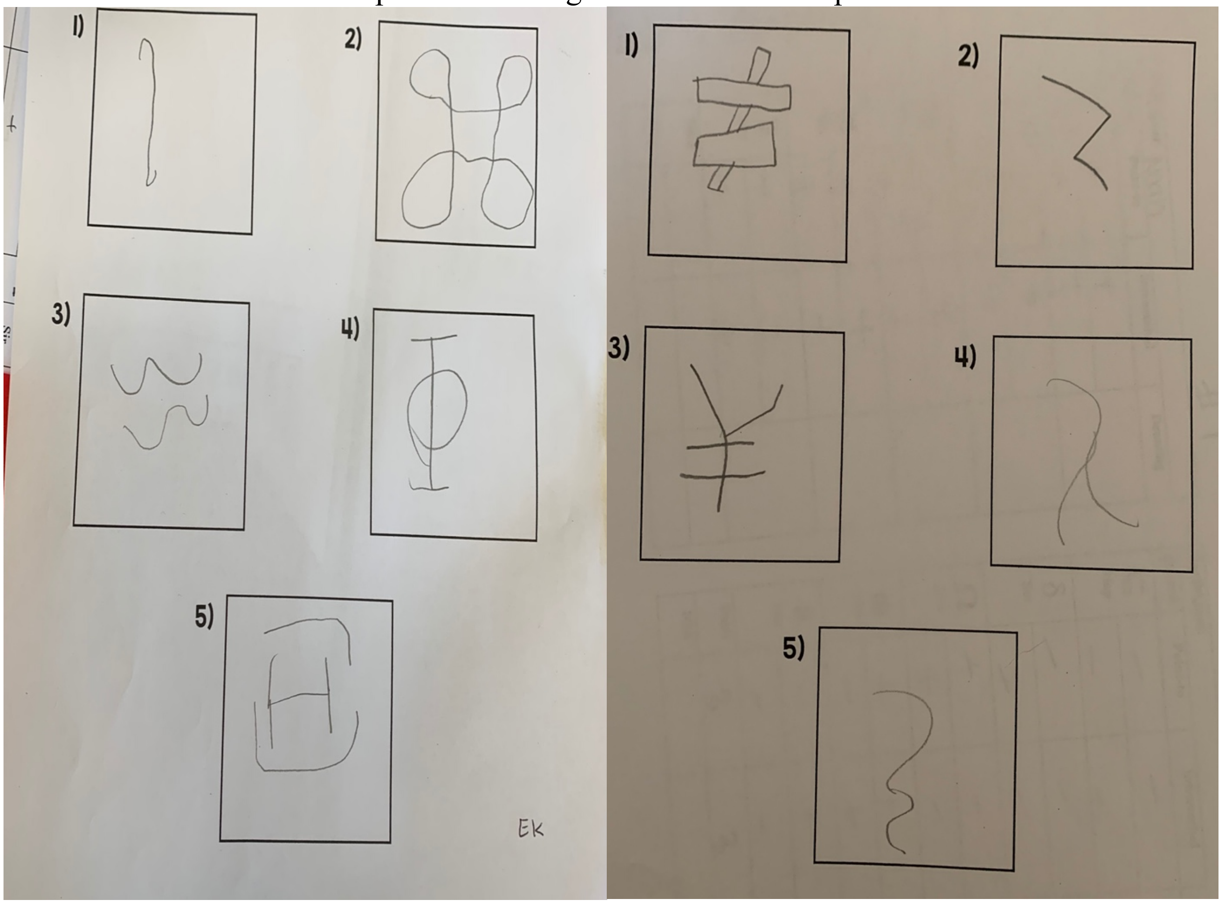
Appendix A

Examples of Drawing Data sheet and Responses



Appendix B

Examples of Sheets used During Conditioned Seeing Probes

Set 4

Name_____________

Directions: Match the symbol to its word.

♮
§
⌥
λ
¥

zim
jev
hod
tul
fap

Appendix C

Examples of Drawing Sheets for Read-Draw Probes

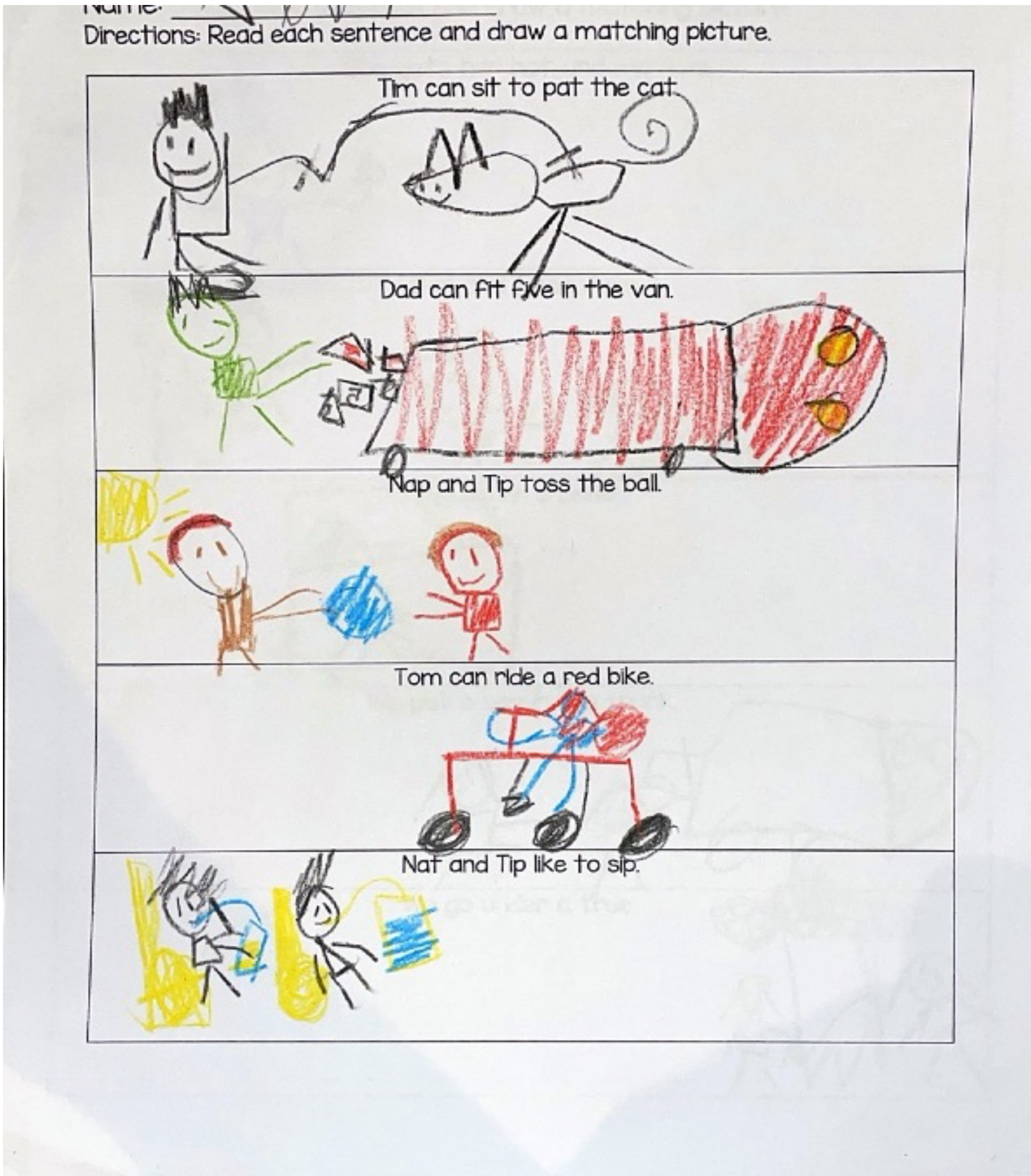
Name: ___________________________

Directions: Read each sentence and draw a matching picture.

Tim can sit to pat the cat.
Dad can fit five in the van.
Nap and Tip like the ball.
Tom can ride a red bike.
Nat and Tip like to sip.

Appendix D

Examples of Correct Drawing components in Read-Draw Probes



Appendix E

Examples of Incorrect Drawing Components in Read-Draw Probes