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Visual Processing Ability: Early Predictor Of Inferential Language And Phonemic Awareness Ability

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DEDICATION

This thesis is dedicated to my parents
David and Sandy Rowlette
for their unwavering support.

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ABSTRACT

A group of 16 typically developing children were selected to participate in a study determining if there is a statistically significant relationship among visual processing, inferential language, and phonemic awareness ability. All participants attended Model Laboratory school, passed a visual and hearing screening, spoke English as the primary language in their household, possessed no history of disorder or disability as evidenced by passing a developmental screener, and ranged in age from 5;4 to 6;4. The study's 16 participants were administered three assessments split between two testing sessions, taking an average of 40 minutes each. Results indicated a quadratic effect existed between an authentic assessment of visual processing (i.e., visual closure) and the Comprehensive Test of Phonological Processing – Second Edition [CTOPP-2] (Wagner, Torgesen, Rashotte, & Pearson, 2013) sound matching subtest scaled scores. A linear relationship existed between an authentic assessment of visual processing (i.e., visual constancy/visual discrimination) and the Preschool Language Assessment Instrument – Second Edition [PLAI-2] (Blank, Rose, & Berlin, 2003) reasoning subtest scaled scores. Results revealed a correlational relationship between one's performance on visual closure tasks and phonemic awareness tasks and one's performance on visual constancy/visual discrimination tasks and inferential language tasks.

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CHAPTER I

INTRODUCTION

Learning to read is a dynamic process that is constantly being sculpted and refined as an individual ages and is exposed to new material, situations, and experiences. Therefore, it is understandable how defining the term ‘reading’ requires a definition that is broad enough to encompass all reading levels, developmental stages, and a variety of modes of contextualized reading behaviors. Mayer and Alexander (2011) define reading as, “the complex communicative behavior of deriving meaning from presented text”.

Tankersley (2003) compares the act of reading to that of weaving. Reading is a complex process made up of smaller threads (skills) that interlock. In order to be a proficient reader, the following six threads must be woven together: readiness/phonemic awareness, phonics and decoding, fluency, vocabulary and word recognition, comprehension, and higher-order thinking. By weaving each of these threads together, a strong foundation is formed that can then be expanded and built upon in order to achieve higher-level processing. When weaving, if one or more strands are missing or is of a weaker thread count, it leads to a weaker tapestry. In a similar sense, if a child does not have a strong foundation in the six reading threads, holes in the reading process develop, thus weakening the overall system.

The American Speech-Language and Hearing Association [ASHA] (2001) explains that difficulty in reading can be a result of problems with production, comprehension, and awareness of language at the sound, syllable, word, sentence, and discourse levels. If problems with reading are the result of difficulties within the five domains of language, then one may question in what way are the domains targeted in emerging literacy instruction?

Emerging literacy and such pre-literacy skills are highly targeted during pre-k and kindergarten grade levels. The Common Core Reading Foundational Skills Standards for kindergarteners across the United States are separated into three main categories, including: print concepts, phonics and word recognition, and fluency. Several of these standards overalap with the domains outlined by ASHA (2001) and are geared toward the instruction of preliteracy skills. For examle, an English Language Arts standard includes a goal for students to “Demonstrate basic knowledge of one-to-one letter-sound correspondences by producing the primary sound of many of the most frequent sounds for each consonant.” Similarly, Roskos, Christie, and Richgels (2003) indicate three critical content categories impacting early literacy: early language comprehension, phonological awareness, and print knowledge. These three categories are composed of skills that produce complex and elaborated understandings and motivations, including: phonological awareness, alphabet letter knowledge, the functions of written language, a sense of meaning-making from texts, vocabulary, rudimentary print knowledge, and the sheer persistence to investigate print as a meaning-making tool.

Phonological awareness is a broad term that describes the ability to recognize words that are made up of a variety of sound units. Phonemic awareness also deals with understanding the function of sounds but is only examining the individual phonemes within the word. According to Stahl and Murray (1994), “Correlational studies have shown strong concurrent and predictive relations between phonemic awareness and success in reading” (p. 222). Phonological sensitivity strongly predicts reading and spelling acquisition which is thought to promote phonological coding of orthography (Burt, 2006), thus allowing the reader to recognize, predict, and identify English spelling patterns that are used in reading, speaking, and language. Burt (2006) identifies this skill as orthographic processing, but overlooks the role of visual processing in the understanding and use of orthographic representations.

Along with skills of phonological awareness and phonemic awareness, is the skill of inferential language. Van Kleeck, Vander Woude, and Hammett (2006) stated that inferential language is critical to later reading comprehension. Inferential language allows children to identify (a) attitudes, points of view, feelings, mental states, or motives of characters; (b) similarities and differences between people, objects, or events within the text or between the text and their world knowledge; (c) causes of events that have occurred or outcomes of events that might occur (predictions); (d) meanings of words; and (e) connections between information given within a text or across texts, or between information given in a text and their world knowledge.

Inferential language and phonemic awareness are often identified as critical skills needed to learn to read. In fact, research has indicated a strong correlational relationship exists between phonemic awareness and reading (Stahl & McKenna, 1994) and between inferential language and reading comprehension (Cain & Oakhill, 1999). In addition, studies have indicated that the act of reading occurs following the completion of information processing through the use of visual, phonological, and episodic memory systems (LaBerge, 1973). Despite research identifying vision as a related processing system in the act of reading, research has yet to fully explore or explain the relationship it may pose within pre-literacy skills necessary for reading acquisition. Limited research examining the relationship between visual processing and other skills associated with reading ability exists.

Knowledge of emergent literacy and the factors impacting the devleopment of such skills is important because it provides professionals with direction during intervention and instruction. Research has determined that inferential language and phonemic awarness are two prerequisite skills that are necessary for the devleopment of reading acquisition. However, there is limited research indicating the significance of visual processing within such instruction. This study will use a multiple regression analysis to examine the relationship between visual perceptual processing and other necessary skills during reading. The purpose of this study was to examine if a correlational relationship exists between visual processing ability, inferential language, and phonemic awareness ability. This study aims to answer the following question, "Is there a statistically significant relationship among visual processing, inferential language, and phonemic awareness ability?"

CHAPTER II

LITERATURE REVIEW

What is visual processing?

Children who pass a vision screening, yet fail to identify the difference between letters, shapes, or objects, are a mystery to most educators. In these cases, the inability to differentiate is not due to poor eyesight, but instead the processing of such information gathered visually. The hindered ability to make sense of information taken in through the eyes is referred to as visual processing disorder (Arky, 2017).

Visual processing is defined as the behavior in which the retinocortical neural pathway is activated and sensitivity to varying stimuli occurs (Everatt, Bradshaw, & Hibbard, 1999). The pathway is comprised of two main streams, the parvocellular and magnocellular systems, which work together to allow visual processing to take place. Each stream plays an equal role in the visual pathway, but differs in their sensitivity to varying visual stimuli. The parvocellular system, "…responds best to slowly changing (low-temporal-frequency) information, to more detailed stimuli, and to color," while the magnocellular system "is more sensitive to gross, moving, or flickering information" (Everatt et al.,1999, p. 243).

What is visual perceptual processing and its significance?

When people think about visual processing, they understand that it is one's ability to process the visual world around them. However, some fail to recognize and/or differentiate the role that visual perceptual skills play within visual processing. An individual may be identified as having visual processing deficits, but it is important to then determine if these deficits are in the area of visual perceptual skills and/or visual motor control.

Throughout the literature, the term “visual perceptual skills [VPS]” is often interrelated with the term, “visual perceptual processing” or “visual perceptual categorization”. Visual perceptual processing, refers to the act of being exposed to a stimulus, attending to the stimulus, and then interpreting the meaning of such stimulus—in order to give it meaning (Andrich, Hill, & Steenkamp 2015). This skill requires a combination of several key component areas including: visual memory, visual spatial relationships, visual form constancy, visual sequential memory, visual figure ground, visual closure, and visual form perception (Andrich et al., 2015). See Appendix A for explanations of each term.

VPS is significant as some researchers have asserted that VPS is necessary for reading acquisition (Andrich et al., 2015; Zhou, McBride-Chang, & Wong, 2014). Andrich et al. (2015) described how initially, when we are shown an image or see something for the first time, we store it in our mind. This image will remain in storage as such, until a relationship is built connecting the image with its associated text. Natural training of VPS must occur prior to the connection being made between visual and written objects, letters, and/or symbols. However, the visual information perceived must be accurate in order for proper connection with previously processed information to take place (Andrich et al., 2015).

Multiple studies have examined the hypothesis that VPS impacts not only later reading ability but can also be a significant predictor of academic success. Wiederholt’s

(1971) findings suggested that two of the five subtests of the Marianne Frostig Developmental Test of Visual Perception [DTVP] (spatial relationships and eye-hand) were useful predictors of academic achievement. However, Colarusso, Martin, and Hartung (1975) found that using the [DTVP] has limited value when using various VPS in predicting one's academic success.

Although their research did not investigate the hypothesis for predicting academic success, Li, Allen, Lien and Yamamoto (2016) findings suggest that visual perception practice stimulates brain plasticity and enhances performance. An orientation discrimination task was presented to both healthy younger and older adults across a three-day training session. Results indicated that both populations improved their discrimination thresholds and response times.

What factors impact visual processing?

In understanding the development and use of visual processing, one must also recognize the role that conceptual and perceptual categorization play. Similar to the ongoing discussion of nature versus nurture, is the question of, "Which occurs first, conceptual or perceptual categorization?" Categorization occurs when one extracts meaning from a perceptual signal and is able to focus on the necessary visual characteristics while eliminating the visual distractions that are irrelevant (Lupyan, Thompson-Schill, & Swingley, 2010). The difference in conceptual and perceptual is the immediacy of the attributes provided (Reed & Friedman, 1972). Perceptual categorization occurs following immediate identification and processing of attributes. Whereas, conceptual categorization of objects involves attributes that are less immediate (Reed & Friedman, 1972).

Lupyan et al. (2010) conducted four experiments to explore the idea that conceptual effects on perceptual processing occur in a dynamic top-down process (i.e., a cognitive process where perceptual processing is effected by higher-level conceptual representations) (Lupyan et al., 2010). The first experiment involved twelve undergraduate students who completed a speeded same/different task using letters: /B/, /b/, and /p/. The letters were presented either simultaneously or sequentially and consisted of within-conceptual-category (Bb) or between-conceptual-category (Bp). The researchers hypothesized that it would take longer to identify "different" for within-conceptual-category (Bb) than between-conceptual-category, and that the category effect (difference in response time between the within-conceptual and between-conceptual-category pairs) would be larger when responding to sequentially presented pairs. The second experiment repeated the procedures from experiment one but rotated the stimuli 90°. This experiment examined the effects of manipulating the stimuli's relation to its conceptual category while maintaining its low-level visual components. The third experiment however, examined the effects of strengthening the association between the visual form and its category. This was accomplished by preceding the procedures from experiment one with a 5-min overt categorization task. The last experiment repeated the procedures from experiment one but replaced the letters with richer stimuli: silhouettes of cats and dogs. This examined effects of stimulus typicality. Results of Lupyan et al., (2010) research indicated that visual processing is affected by nonvisual properties. The study found that it took longer to judge two stimuli to be physically “different” when they were in the same category. When the participant was required to categorize the stimuli prior to making same/different judgments, responses were made quicker and with greater reliability. The research determined that low-level visual representations are constantly under the influence of higher-level representations. Results provide evidence to support the notion of, “categorical perception as a dynamic process, arising from a modulation of visual representations by higher-level conceptual representations” (Lupyan et al., 2010, p. 9).

In addition to categorization, attention has been identified as a factor that impacts an individual’s ability to utilize visual processing. Attention affects the responses of sensory neurons which can make the difference between success and failure with behavioral performance. Maunsell and Cook (2002) discussed that spatial attention specifically has been found to affect neuronal responses in every visual cortical area. Attending to a stimulus within one’s receptive field yields a stronger neuronal response in comparison to the strength of neurons when responding to stimuli outside one’s receptive field. In addition, modulation by attention is at its weakest in the earliest stages of visual cortex and strongest in the latest stages (Maunsell & Cook, 2002).

How is visual processing assessed?

When assessing one’s visual processing there are several professionals that play a role, depending on what symptoms the patient is presenting. Professionals may include: a pediatric ophthalmologist, pediatric optometrist, neuropsychologist, and/or behavioral optometrist (Arky, 2017). A pediatric ophthalmologist will complete an eye exam to look for physical deficits. A pediatric optometrist provides primary eye care to children and may prescribe glasses or evaluate the patient's vision or eye problems. A neuropsychologist is skilled and qualified to diagnose learning issues. They will use a series of tests designed to measure intelligence, academic skills, language skills, memory, and attention. A behavioral optometrist is capable of providing vision therapy. However, limited empirical evidence is available detailing its effectiveness (Arky, 2017).

Additional insight regarding the assessment of visual processing can be found when examining the literature related to assessment of multiple sclerosis [MS]. MS is a complex genetic disease associated with inflammation in the central nervous system white matter (Hafler, 2004). Researchers utilized two visual processing assessments when identifying the sensitivity and validity of pediatric MS in the Brief Visuospatial Memory Test-Revised and the Symbol Digit Modalities Test (Smerbeck et al., 2011). The Brief Visuospatial Memory Test-Revised is a test of visuospatial memory and can be used as a screener, a part of a large neuropsychological battery, or as a way to document progress over time. The test battery has six stimulus forms that contain six geometric figures. The assessment is broken into three main trials: learning trials, delayed recall, and recognition trial. The Symbol Digit Modalities Test is an assessment for examinees 8 years and older and screens for organic cerebral dysfunction. The assessment requires the examinee to substitute a number, either expressively or receptively, for randomized presentations of geometric figures.

Who has difficulty with visual processing?

After assessing one's visual processing, a professional may determine that the child or adult has visual processing issues (Arky, 2017). Symptoms of visual processing deficits include: doesn't pay attention to visual tasks, easily distracted, eye strain, poor reading comprehension, difficulty spelling familiar words with irregular spelling patterns, and misreading letters. Difficulty with visual processing can affect one's academics, emotional state, and ability to perform everyday life skills (Arky, 2017). There are eight subskills within visual perceptual processing: visual spatial relations, visual sequential memory, visual discrimination, visual form constancy, visual memory, visual closure, and visual figure ground (Andrich et al., 2015). See Appendix A for definitions of each type of visual processing skill. Although researches are unsure of the exact cause for such processing difficulties, they do know that there is a breakdown where the brain fails to accurately receive and read the visual information sent by the eyes (Arky, 2017).

Researchers have found that individuals with MS in particular, have difficulty with visual processing. Participants with MS scored significantly lower than typically developing controls when visual processing speed and memory were assessed (Smerbeck et al., 2011). Participants also scored poorly on free recall tasks, which may be a result of impairments in encoding, retention, or retrieval (Smerbeck et al., 2011).

Along with MS patients, Georgiou, Papadopoulos, Zarouna, and Parrila (2012) found that children with developmental dyslexia also have difficulty with visual processing. Their study concluded that participants with developmental dyslexia performed poorer on visual processing measures when compared to their chronological age-matched controls. Additionally, the researchers wanted to determine if lower-level processes were related to phonological and orthographic deficits. Both the subgroup of children with dyslexia and the children without visual processing deficits demonstrated deficits with orthographic processing (Georgiou et al., 2012).

What is inferential language and its significance?

According to Van Kleeck, Woude, and Hammett (2006) two types of meaning within language exist, including literal and inferential language. Literal language is best described as the information that can be readily perceived and then used, discussed, or described (Zucker, Justice, Piasta, & Kaderavek, 2010). Inferential meaning can be defined as, “that which is not explicitly stated but deduced (presumed) from what is said” (Hegde & Maul, 2006, p. 445). The difference between literal and inferential language is in the amount of information provided within the text, picture, or situation (Van Kleeck et al., 2006). If there is not an adequate amount of information provided, the individual is forced to rely on background information or reasoning skills. Individuals rely upon inferential language ability to communicate effectively. In fact, inferential language ability assists communicators in gaining meaning from conversational exchanges.

In addition to playing a role in oral language, researchers have demonstrated that the ability to infer assists communicators with varied aspects of literate language ability. In fact, Caccamise and Synder (2005) found that individuals use inferential processes to build the gap between syntactic or subject referent relations when reading. The reader may resort to recalling real world knowledge or experiences as an effortful form of problem solving. This process results in an adequate depiction of the literature topic and a deeper level of comprehension on behalf of the reader. In addition, Rayner et al. (2001, 2002) discovered that in circumstances where an individual demonstrates difficulty using inferential processing, there may be a cognitive overload or breakdown in comprehension (Rayner et al., 2001, 2002). Finally, Cain and Oakhill (1999) concluded that success with inferential language use is a strong correlate to success in reading comprehension.

Who has difficulty with inferential language?

Inferential language requires children to use their language skills to infer or abstract information by analyzing the material being presented (Zucker et al., 2010). Younger children's knowledge of or ability to use inferential language skills are influenced by adult's explicitly scaffolded instruction on such skills (Zucker et al., 2010). For some, the ability to use inferential language is not readily available or scaffolded. Research has described various populations that have been found to have difficulty with inferential language.

One population that has been found to have deficits in the area of inferential language is individuals with specific or pragmatic language impairments. Adams, Clarke, and Haynes (2009) chose sixty-four children with language impairments, aged six to 11 years, who attended language units in the north-western region of England. The participants had to speak English as their primary language, must not have a hearing loss, and were required to fall within normal range on cognitive tests. Two tasks were administered to the participants: an inference comprehension task and a task of sentence comprehension. The children with language impairments were found to have lower raw scores on the inference comprehension task than chronological aged matched typically developing children. Adams et al. (2009) concluded that, “Children with pragmatic language impairments are more likely than children with non-pragmatic specific language impairments to have difficulty with a story-plus-question-type inference comprehension task” (p. 314).

Lehrer and deBernard’s (1987) and Ford and Milosky’s (2003) research represent two studies that provide further confirmation of inferential processing deficits in children with language impairments. Lehrer and deBernard (1987) concluded that the preschoolers within their study who had language delays performed poorly on both the literal and inferential sections of the Preschool Language Assessment Instrument. Ford and Milosky (2003) found that children in their study with language impairments demonstrated greater difficulty “developing the kinds of mental representations during a story that would help them anticipate, and hence infer, emotions” (p. 28).

Groen, Laws, Nation, and Bishop, (2006) found that individuals with Down syndrome demonstrate difficulty in areas of inferential processing as well. The study reported on a case of a girl (K.S.) with Down syndrome. K.S. was a participant who exhibited difficulty in the area of knowledge-based inferences in reading comprehension. Individuals with Down syndrome thus show relative weakness in the area of reading comprehension as a result of inferential processing (Nash & Heath, 2011).

How does one facilitate growth in inferential language?

With the large population of individuals that are effected by deficits in inferential language, one may assume that adequate research would be present regarding intervention styles and strategies. Unfortunately, little research has been conducted in regards to specific strategies for strengthening inferential language. However, many studies have examined strategies for strengthening inferential reading ability or comprehension, which indirectly affects inferential language. Van Kleeck et al., (2006) conducted a study using thirty children (17 boys and 13 girls) ranging in age from 3;10 to 5;0 who attended a Head Start preschool program. The study used a randomized control pre- and post-test data analysis to examine how repeated one-on-one book sharing intervention effects both literal and inferential language development. It was determined that intervention, such as book sharing, would facilitate foundational knowledge of inferencing. This, in turn, would support later reading comprehension.

Zucker et al. (2010) examined the role that teachers play in the process of inferential language development during school-based shared reading. Results indicated that using informational genres stimulates a cognitively challenging conversation encouraging natural inferencing to occur. The level of abstraction of the teacher's questions was directly related to the child's level of response. Zucker et al. (2010) also determined that students who had initially low vocabulary benefited more from literal questioning; however, students who had high vocabulary initially benefited more from inferential questioning.

Walker, Munro, and Rickards (1998) conducted a study examining the use of pictures as an inferential reading strategy. Participants included sixty underachieving readers who were prelingually deaf that underwent a teaching program consisting of eight categories: visualization, prediction, conventions and traditions, prior knowledge, relationships, characterization, the main idea, and author's intent. The use of pictures allowed the child to stimulate specific cognitive and thinking skills. Findings suggest that one group did show strengths in inferential comprehension but not literal comprehension and that continued purposeful intervention for participants who are deaf or hard of hearing has the potential to prevent them from falling behind academically in comparison to their peers with normal hearing. This study is directly related to participants who are deaf or hard of hearing. Results do not explicitly state the correlation between inferential reading strategies through pictures with children who have hearing acuity.

What is phonemic awareness and its significance?

Numerous definitions of phonemic awareness have been identified throughout research and vary in theoretical underpinnings and support. Phonemic awareness can be defined as the conscious awareness that words are made up smaller units of sound called phonemes (Snider, 1997). Cunningham (1998) defines phonemic awareness as, “the ability to examine language independently of meaning and to manipulate its component sounds”. Although similar, phonemic awareness should not be confused with phonological awareness, the phonological processing ability most closely related to literacy. Phonological awareness refers to one’s ability to recognize, discriminate, and manipulate the sounds in one’s language (Anthony & Francis, 2005). Phonological awareness is not a unitary skill but a term than encompasses several skills that allow for varying degrees of sound division (words, syllables, rimes, phonemes, etc.), including phonemic awareness (Hesketh, Dima, & Nelson, 2007).

Children learn that through the use of a hierarchy of metalinguistic skills, they are able to interpret and express the meaning of different phonemes and phoneme combinations. Phonemic awareness skills also enable children to use sound-letter correspondence to read and write (Griffith & Olson, 1992). One level of phonemic awareness that is simpler for children to understand is the concept of naming and/or recognizing rhymes. Additionally, levels of blending phonemes and segmenting syllables are necessary for phonemic awareness acquisition. The most difficult task involves segmenting words into phonemes and manipulating phonemes to build new words (Griffith & Olson, 1992). See Appendix B for examples of phonemic awareness tasks.

Although this metalinguistic skill is complex and difficult for some, it is vital to the reading acquisition process (Griffith & Olson, 1992). By establishing a foundation of phonemic awareness skills that are automatic, it will minimize the need to divert ones conscious attention away from the processes of reading comprehension. Additionally, the child must realize the relationship between oral and written language and letter-sound correspondence. This ability will transition to reading and writing novel words through the coordination of letter-sound relationships (Griffith & Olson, 1992).

Who has difficulty with phonemic awareness?

Phonemic awareness has been found to be an early indicator of later reading and spelling achievement. Therefore, it is not surprising that research identifies difficulty with phonemic awareness as an early indicator that something is wrong with the child (Snider, 1997).

Typically children who are developing their pre-literacy skills do not take the time to consciously think about phonemic awareness (Griffith & Olson, 1992). In the same notion, phonemes are not discrete units and therefore are not easy for children to segment. It can also be difficult for children to grasp phonemes because each unit of sound does not hold meaning. Children are used to seeing and understanding words, which do hold meaning (Griffith & Olson, 1992).

Children with language impairments are one population who will need intensive instruction on phonemic awareness (Ukrainetz, Ross, & Harm, 2009). Intervention needs to be longer and more frequent than that provided to typically developing children. However, research has found that phonemic awareness can improve in a rather short period of time, regardless of the source of learning (Ukrainetz et al., 2009).

Along with language impairments, children who have speech disorders are at risk for having difficulty with the acquisition of literacy and phonological awareness. Errors in phonological processing or articulation have been found to result in difficulty with phonemic awareness tasks and word decoding, effecting overall literacy development (Holm, Farrier, & Dodd, 2008). Children base their internal lexical phonological representation off of words they have acquired, information about their structure, and information related to semantics. When these features are distorted and/or learned incorrectly, the child will experience incorrect word recognition and productions, impacting their ability to read and write (Holm et al., 2008).

How does one facilitate growth in phonemic awareness?

A substantial body of evidence exists supporting the practice of phonemic awareness instruction. In fact, phonemic awareness was identified as one of the five areas of literacy instruction by the National Reading Panel (2000). The National Reading Panel conducted a meta-analysis to determine the role and impact of phonemic awareness instruction on reading and spelling development. Results showed that: phonemic awareness instruction is effective in teaching children to attend to and manipulate speech sounds in words, that teaching this skill of manipulating sounds helps the child read, and it helps kindergarteners and 1st graders learn to spell. It is suggested that instruction on phonemic awareness be taught with letters, explicitly focusing on one or two types of phoneme manipulation, and be taught in small groups (National Reading Panel, 2000).

Phonemic awareness instruction can be presented in various forms and using different approaches. One approach takes a vertical or sequential approach, where one skill is taught at a time until mastery is met. Within this approach instructors will present larger units of sound and progress to smaller units. The smallest unit of sound and the last skill taught is at that of a phoneme (Ukrainetz et al., 2009).

Reading and Van Deuren (2007) examined the optimal time for phonemic awareness instruction. A preliteracy skill necessary for reading is decoding. Spencer, Schuele, Guillot, and Lee (2008) states that when coupled with letter-sound instruction, phonological awareness can result in improved word decoding. In order to decode efficiently, the reader must first master the skill of phonemic awareness and understand the correlation between phonemes and written or spoken sounds. This allows the child to match sounds with written symbols, what most identify as “sounding out”. They determined that learning phonemic awareness within the first four months of 1st grade is early enough to support later reading development.

Flett and Conderman (2002) identified 20 different instructional techniques for targeting phonemic awareness: (1) Teach nursery rhymes, (2) Teach simple poems and finger plays that use rhyming words, (3) Draw attention to rhyming words as they occur in normal classroom interactions, (4) Read stories that contain many rhymes, (5) Play the “I Spy” game using the initial sounds of words as the clues, (6) Create a sound box in your classroom, (7) Have students sort picture cards based on the initial sound in the name of the picture, (8) Extend the picture card activity to spoken language, (9) Develop students’ ability to split syllables into their smaller phonemes by breaking off the first phoneme in a syllable or word, (10) Play “change a name”, (11) Play phoneme deletion games by omitting a sound in a word, (12) Use and build on students’ phonemic knowledge during transition times, (13) Play an alphabet sound game, etc..

Statement of the Research Problem

Speech language pathologists [SLP] are often the first to identify a child who is struggling to read due to the child’s difficulty with the use and understanding of language (ASHA, 2017). Currently, reading assessment and intervention addresses some if not all of the two strands woven into skilled reading including language comprehension and word recognition (Scarborough, 2001). Within these two categories one will find inferential language and phonemic awareness, subcategories of verbal reasoning and phonological awareness. Inferential language and phonemic awareness are often identified as critical skills needed to learn to read. In fact, research has indicated a strong correlational relationship exists between phonemic awareness and reading (Stahl & McKenna, 1994) and between inferential language and reading comprehension (Cain & Oakhill, 1999). Additionally, visual perceptual processing skills [VPS] have been found to be an influential skill in the acquisition of reading (Andrich et al., 2015; Zhou, McBride-Chang, & Wong, 2014).

Despite the research relating VPS and reading, and pre-literacy skills and reading, there is limited research examining the relationship between VPS with prerequisite reading skills targeted by speech language pathologists'. It is important to determine what skills and abilities influence the acquisition of pre-literacy skills such as phonemic awareness and inferential language in order for reading intervention to be effective. However, limited research examining the relationship between visual perceptual processing and other skills associated with pre-literacy and reading ability currently exists.

Identifying the relationships between visual processing and pre-literacy skills may lead to improvements in pre-literacy intervention for children with disabilities or those that are at risk for later reading difficulties. In addition, understanding speech language pathologists' role within literacy intervention, the current role of occupational therapists within visual processing intervention, and the possible correlation between the two skills would lead to an increase in the necessity for a collaborative approach to therapy.

CHAPTER III

METHODOLOGY

This chapter describes the methodology utilized in this study, examining the relationship among visual processing, phonemic awareness, and inferential language. The chapter begins with a description of the study's purpose and research question. The chapter then identifies and explains the research design, sampling paradigm, participant selection, and recruitment. Following this information, the data sources and the approach to data collection are described. The chapter concludes with an explanation of the data analysis.

Purpose and Research Questions

The purpose of this study was to examine if a correlational relationship existed between visual processing, inferential language, and phonemic awareness ability. This study aimed at answering the following question: "Is there a statistically significant relationship among visual processing, inferential language, and phonemic awareness ability?"

Research Design

This study used a multiple regression analysis to determine the relationship between various visual processing skills (i.e., visual constancy, visual discrimination, visual closure), inferential language, and phonemic awareness. Multiple regression prediction models are the extensions of simple linear regression models, where more than one predictor variable is taken into consideration (Mielke & Berry, 2003). This study utilized five predictor variables per one response variable.

Sampling Paradigm and Participant Selection

This study utilized a purposive and convenience sampling of school-aged children. A purposive sampling was utilized in this study in an effort to identify participants who met a specific inclusion criteria related to developmental and educational history. A convenience sampling was used in the sense that participants were recruited from a laboratory school at Eastern Kentucky University.

The inclusion criteria for the participants of the study included:

1. The participant must attend Model Laboratory School.
2. The participant must be between the age of 3 year, 0 month and 5 year, 11 months.
    a. After receiving all assent and consent forms, it was discovered that all 16 participants ranged in age from 5;4 and 6;4.
3. The participant must successfully pass a visual and hearing screener.
4. The participant must speak English as the primary language in the household.

5. The participant must have no history of a disorder or disability as evidenced by passing the developmental screener at Model Laboratory school.

Recruitment

All study participants were recruited from Model Laboratory School, a preschool through grade 12 laboratory school within Eastern Kentucky University’s College of Education. Students who are interested in attending Model, are placed on a waitlist and accepted on a “first-come, first-served” basis. The school accepts 60 students per grade level, leading to an enrollment of approximately 720 students for all grade levels. Model Laboratory School places an emphasis on traditional academics while promoting the humanities, arts, and physcial education. Partnership with Eastern Kentucky University [EKU] allows for a joint collaboration between college faculty, Pre-K-12th grade faculty, college practicum/co-op students, and student teachers.

Model Laboratory School provided clearance for data collection of students in kindergarten to occur during the 2016-2017 school year. Only students attending Model Laboratory's Kindergarten classes and those who fit within the inclusion criterion were identified and recruited as prospective participants (See Appendix C).

The families of prospective participants were sent a letter identifying the purpose of the study and a detailed description of the study's procedures (See Appendix D). Parents interested in giving permission for their child to participate in the study were then provided with an informed consent form (See Appendix E), parent/guardian permission form (See Appendix F), Protection of Pupil Rights Amendment [PPRA] notice and consent form (See Appendix G), and Student Authorization to Release Academic/Educational Record form (See Appendix H). Parents and guardians were asked to return signed documents to their child's kindergarten teacher. Once the signed consent forms were obatined, a copy of it was made and returned to the parent/guardian along with an assent form for them to sign. All forms were signed by participants and their parents or guardians prior to participation in the study.

Data and Data Collection

Participants were administered three assessments split between two sessions, which took an average of 40 minutes each. The three assessments included: SET authentic assessment (SET Enterprises Inc.), Comprehensive Test of Phonological Processing [CTOPP-2], (Wagner, Torgesen, Rashotte, & Pearson, 2013) and the Preschool Language Assessment Index [PLAI-2], (Blank, Rose, & Berlin, 2003).

SET authentic assessment. The SET authentic assessment, an evaluation based upon the premise of the SET card game of visual perception (SET Enterprises, Inc.), was used to assess participants' visual perceptual processing abilities. The purpose of the SET game (SET Enterprises, Inc.) was to identify groups of cards that represent a "SET." SET cards contain three varying features including: color (i.e., red, purple, green), shape (i.e., oval, diamond, squiggle), and number of shapes (i.e., one, two, three). There was only one rule to make a SET. A SET was three cards in which each individual feature was either all the same on each card or all different on each card.

The SET authentic assessment was comprised of two parts. Part A (i.e., SET detection), tested two categories of visual perceptual processing identified as visual constancy and visual discrimination. In Part A (i.e., SET detection), participants were shown three SET cards and asked if the cards did or did not represent a SET. SET detection required the participant to rely on their visual perceptual processing abilities to examine three cards at once and find similarities (i.e., visual constancy) and differences (i.e., visual discrimination). As a result, the participant had to determine if the combination of each feature, on each card, did or did not represent a complete SET.

Part B (i.e., SET completion), tested one category of visual perceptual processing identified as visual closure. In Part B (i.e., SET completion), participants were shown an image of two SET cards and were asked to receptively identify the third SET card needed to complete (i.e., visual closure) the SET, given three card options. SET completion required the participant to use their visual perceptual processing skills to examine the two cards presented and analyze the features on each. When comparing these two cards with the three choices given, the participant was able to infer which card was needed to complete (i.e., visual closure) the SET.

Following the administration of each section of the SET authentic assessment, scores were calculated and a percentage of accuracy was obtained for each section. Scores were based out of 20 possible correct answers.

Preschool Language Assessment Index – Second Edition. The PLAI-2 (Blank, Rose, & Berlin, 2003) is used to evaluate participants' inferential language ability. The

PLAI-2 (Blank et al., 2003) is a norm-referenced assessment that has six subtests that assesses a child's ability to meet the demand of classroom discourse. This assessment takes approximately 30 minutes to administer and provides the examiner with: *scaled scores, discourse ability scores, percentile ranks, and age equivalents.* The test book contained all of the necessary stimuli including: verbal instructions to the child, printed instructions to the examiner for item administration, and scoring criteria. All items were administered in the order in which they appeared. Although the assessment included six subtests, only the results from the Reasoning subtest were used in this study. Reasoning questions were mixed throughout the assessment and examined one's ability to predict events and justify ideas (e.g. What will happen if…? How do you know that…?"). A raw score was obtained by adding each correct answer (score of 1) within the reasoning subtest.

Comprehensive Test of Phonological Processing – Second Edition. The sound matching subtest of the CTOPP-2 (Wagner et al., 2013) was used to assess the participants' phonemic awareness skills. The CTOPP-2 (Wagner et al., 2013) is a norm-referenced assessment that takes approximately 40 minutes to administer. This assessment yields six types of normative scores: *age equivalents, grade equivalents, percentile ranks, subtest scaled scores, composite indexes, and developmental scores*. The CTOPP-2 (Wagner et al., 2013) consists of twelve subtests including: elision, blending words, sound matching, phoneme isolation, blending nonwords, segmenting nonwords, memory for digits, nonword repetition, rapid digit naming, rapid letter naming, rapid color naming, and rapid object naming. Only results from the sound matching subtest were used in this study.

The sound matching subtest consisted of 20 test items and measured the child's ability to select words with the same initial and final sounds (e.g. "This is a picture of a sock." *Examiner turns page.* "Point to the picture that begins with the same sound as sock, /S/."). A raw score was obtained by adding the correct number of responses prior to reaching the ceiling. Correct responses were scored as 1 and incorrect as 0. Ceiling was met when the child was presented with at least seven test items and they missed four of the seven.

Data Analysis

Using a multiple regression analysis, results from each of the three assessments (SET authentic assessment, PLAI-2 (Blank et al., 2003) Reasoning subtest, CTOPP-2 (Wagner et al., 2013) Sound Matching subtest) were analyzed and compared. Results from the PLAI-2 (Blank, Rose, & Berlin, 2003) Reasoning subtest and CTOPP-2 (Wagner et al., 2013) Sound Matching subtest were analyzed using subtest scaled scores. The SET authentic assessment results were analyzed using a percentage of accuracy. The investigator then determined if each participant's SET ability predicted his or her inferential language and/or phonemic awareness ability using a backwards elimination selection model.

CHAPTER IV

RESULTS

A multiple regression analysis was used to determine the predictability of visual processing on inferential language and phonemic awareness. The study's 16 participants were administered three assessments split between two testing sessions, taking an average of 40 minutes each. The participants consisted of kindergarteners who attended Model Laboratory. Four consent forms were provided to students who passed the developmental screener, spoke English as the primary language in the household, and fell within the age range of 5;4 and 6;4. Of those invited to participate, 16 returned all four consent forms and were chosen to participate in the study. The 16 participants include eight females and eight males.

CTOPP-2 Sound Matching Subtest

The CTOPP-2 (Wagner et al., 2013) is a norm-referenced test that measures phonological processing abilities related to reading. It was developed to aid in the identification of individuals from kindergarten to college that may benefit from further phonological instruction. The CTOPP-2 (Wagner et al., 2013) was normed on a sample of 1,900 individuals in six states: California, Florida, North Dakota, New York, Oregon, and Texas. Three types of phonological processing are assessed throughout including phonological awareness, phonological memory, and rapid naming. Within each construct the assessment examines specific skills which are broken into 12 subtests. The CTOPP-2 (Wagner et al., 2013) is normalized for two different age groups: 4-6 and 7-24.

Only the sound matching subtest (i.e., Core, 4-6 Years) was used during this study. The sound matching subtest consisted of 26 items that measured the extent to which an individual could match sounds. While pointing to the corresponding pictures, the examiner reads one word, pauses, and then names the remaining three words. The first 13 items requires the examinee to point to the picture that corresponds to the word that starts with the same sound as the word the examiner stated first. The last 13 items, requires the examiner and examinee to continue the previous steps, except for pointing to the word that ends in the same last sound as the first word the examiner stated. Items were repeated once if the examinee appeared to forget the words the examiner said. When scoring the participant's answer, 1 point was given for a correct response and 0 for an incorrect response. All items were presented unless ceiling was met prior to administration of all test items (i.e., three consecutive incorrect items).

Each participant's (N=16) subtest raw score was calculated and then converted to age and grade equivalents, percentile ranks, subtest scaled scores and descriptive terms. Subtest scaled scores were based on a normal distribution with a mean of 10 and standard deviation of 3. Descriptive ratings included: very poor (SS: 1-3), poor (SS: 4-5), below average (SS: 6-7), average (SS:8-12), above average (SS:13-14), superior (SS:15-16), and very superior (SS: 17-20).

Participant 6 scored a subtest scaled score of 8, average descriptive rating. Participants 3, 14, and 16 scored a subtest scaled score of 9, average descriptive rating. Participants 2 and 7 scored a subtest scaled score of 10, average descriptive rating. Participants 5 and 11 scored a subtest scaled score of 11, average descriptive rating.

Participants 12 and 13 scored a scaled score of 12, average descriptive rating. Participants 1, 4, 8, 10, and 15 scored a subtest scaled score of 13, above average descriptive rating. Participant 9 scored the highest subtest scaled score of 14 placing the participant within the above average descriptive rating category. See Table 1.

Table 1

CTOPP-2 Sound Matching Subtest Scaled Scores

Descriptive Term	Very Poor			Poor		Below Average		Average					Above Average		Superior		Very Superior			
Subtest Scaled Score	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
Participant																				
1													X							
2										X										
3									X											
4													X							
5											X									
6								X												
7										X										
8													X							
9														X						
10													X							
11											X									
12												X								
13												X								
14									X											
15													X							
16									X											

SET Part B: Completion

The SET authentic assessment was based off of the visual processing game called SET. The assessment was broken into two sections: Part A-Detection and Part B-Completion. Prior to administering 20 test items per section of the SET assessment, the examiner presented the components of the SET game, instructions on how to make a SET, and three trial items per section. Part B: Completion assessed participants understanding and use of the visual processing skill called visual closure. The section of the authentic assessment required the examiner to identify three different cards by stating their shape, color, and number of shapes. The examiner then asked the participant, “Is this a SET?”. The participant was allowed to indicate a negative or affirmative response either nonverbally or verbally. Correct responses were scored 1 and incorrect responses were scored 0. All 20 test items were administered, despite the participant’s number of incorrect responses.

The SET authentic assessment did not provide descriptive ratings. However, scores on each section of the SET authentic assessment were described using ranges in percentage of accuracy. Scores out of 20 that fell between 1 and 3 were in the 5%-15% percentage of accuracy category. A score achieved of 4 or 5 fell in the 20%-25%, 6 or 7 fell in the 30%-35%, scores 8-12 fell in the 40%-60%, 13 and 14 fell in the 65%-70%, scores 15 and 16 fell in the 75%-80%, and if a participant scored 17-20 correct responses, they fell in the 80%-100% percentage of accuracy category.

Participants 5 and 10 scored 6 out of 20, falling within the 30%-35% percentage of accuracy category. Participant 15 scored 8 out of 20, and fell within the 40%-60% percentage of accuracy category. Participant 14 achieved a 9, and fell within the 40%-60% category. Participant 6 scored an 11, 40%-60% category. Participant 2 scored a 12, 40%-60% category. Participant 7 scored a 14, and fell within the 65%-70%. Participants 3, 11, and 16 scored a 15, and fell within the 75%-80%. Participant 8 scored a 16, still falling within the 75%-80% category. Participant 4 and 9 scored an 18, and fell within the 85%-100%. Finally, participant 1 and 14 scored the highest with a 19, and there scores placed them in the 85%-100% percentage of accuracy category. See Table 2.

Table 2

SET Part B: Completion Percentage of Accuracy

Range in % of Scores	5%-15%			20%-25%		30%-35%		40%-60%					65%-70%		75%-80%		85%-100%			
Numerical Score	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
Participant																				
1																			X	
2												X								
3															X					
4																		X		
5						X														
6											X									
7														X						
8																X				
9																		X		
10						X														
11															X					
12																X				
13																			X	
14									X											
15								X												
16															X					

Multiple Regression Analysis: CTOPP-2 Sound Matching Subtest

A complete second order multiple regression model was analyzed for the two response variables, PLAI-2 (Blank et al., 2003) Reasoning subtest and CTOPP-2 (Wagner et al., 2013) Sound Matching subtest. The five predictor variables used to predict each model were: SET Detection, SET Completion, SET Detection x SET Detection, SET Completion x SET Completion, and SET Detection x SET Completion. A backward elimination selection procedure model was used to perform regression analyses for each response variable until only statistically significant predictors were included in the model.

A regression analysis was performed for CTOPP-2 (Wagner et al., 2013) Sound Matching subtest scaled scores which yielded Model 1. Using the backward elimination selection procedure model and a hierarchical structure, all predictor variables were present initially and then were removed one at a time until a model that was best fit was selected. Therefore, the first regression analysis performed for CTOPP-2 (Wagner et al., 2013) Sound Matching subtest included all five predictor variables (DF=5). See Table 3.

Table 3

CTOPP-2 Sound Matching Scaled Score Regression Analysis (N=16)

	Model 4				
	DF	SS	MS	F-Value	P-Value
Regression	5	28.9482	5.7896	2.41	0.111
Detection	1	0.0324	0.0324	0.01	0.91
Completion	1	15.6475	15.6475	6.51	0.029
Detection*Detection	1	0.0601	0.0601	0.02	0.878
Completion*Completion	1	24.2229	24.2229	10.07	0.01
Detection*Completion	1	1.9518	1.9518	0.81	0.389
Error	10	24.0518	2.4052	24.0518	2.4052
Total	15	53			
R^2			54.62%		

The final model is illustrated in Table 4. Table 4 gives the analysis of variance for the final model to predict CTOPP-2 (Wagner et al., 2013) Sound Matching subtest scaled scores. The overall model is significant (F2,13= 6.61, p=.01). Within this model, results indicate that 50.76% of the variation (R^2=50.44%) in CTOPP-2 (Wagner et al., 2013) Sound Matching subtest scaled scores of kindergarten students at Model School is explained by the linear and quadratic relationship of CTOPP-2 (Wagner et al., 2013) Sound Matching subtest scaled scores and the SET Part B: Completion percentage scores based on Model 1. The linear and quadratic terms for Completion were also significant with (F1,13=10.03, p=.007) and (F1,13=11.52, p=.005), respectively. The fitted multiple regression model for CTOPP-2 (Wagner et al., 2013) Sound Matching subtest scaled scores is: CTOPP-2= 20.29-.362Completion+.0031Completion^2. See Table 4.

Table 4

CTOPP-2 Sound Matching Scaled Score Regression Analysis (N=16)

	Model 1				
	DF	SS	MS	F-Value	P-Value
Regression	2	26.731	13.365	6.61	0.01*
Completion	1	20.276	20.276	10.03	0.007**
Completion*Completion	1	23.278	23.278	11.52	0.005**
Error	13	26.269	2.021		
Total	15	53			
R^2			50.44%		

*p <.05. **p <.01.

Using the fitted multiple regression model for CTOPP-2 (Wagner et al., 2013) Sound Matching subtest, scores for the CTOPP-2 (Wagner et al., 2013) Sound Matching subtest were predicted. Table 5 outlines the five prediction regression equations used. The first regression equation indicates 95% confidence that for all students who scored 60% on SET Part B: Completion, the mean CTOPP-2 (Wagner et al., 2013) Sound Matching subtest scaled scores would be between 8.37 and 10.85.

Table 5
Prediction for CTOPP-2 Sound Matching Subtest

SET Part B: Completion Percentage	95% CI	95% PI	CTOPP-2 Reasoning Estimate
60	8.37-10.85	6.30-12.92	9.61
70	8.84-11.12	6.70-13.25	9.98
80	10.01-11.91	7.75-14.18	10.96
90	11.33-13.79	9.25-15.87	12.56
95	11.92-15.26	10.09-17.09	13.59

PLAI-2 Reasoning Subtest

The PLAI-2 (Blank, Rose, & Berlin, 2003) was a standardized instrument that investigated the relationship between classroom discourse and aspects of academic achievement and cognitive functioning. The assessment was normed on a sample size of 463 children residing in 16 states. The PLAI-2 (Blank et al., 2003) was developed for children ages 3 years, 0 months through 5 years, 11 months. The assessment consisted of two different Profiles/Examiner Record Booklets: one booklet was for children who are 3 years old; a second booklet was for use with children who were 4 and 5 years old. The PLAI-2 (Blank et al., 2003) included two types of assessment: standardized (i.e., norm-referenced) and non-standardized (i.e., informal).

The assessment consisted of four different levels of language abstraction, two modes of response, and two aspects of pragmatic behavior. The four levels of language abstraction assessed were: matching perception, selective analysis of perception, reordering perception, and reasoning about perception. Matching perception required the examinee to name or select objects, entities, and actions, or perform imitations (i.e., "What is this called?"). Selective Analysis required the examinee to name or select objects, entities, and actions based on function, multiple features, or the integration of characteristics (i.e., “What shape is the bowl?”). Reordering required the examinee to name or select perceptually subtle but significant aspects of objects, entities, and actions based on linguistic constraints (i.e., “Show me the part of the egg that we don’t eat.”). Reasoning required the examinee to name or select objects, features, functions, and classifications to predict outcomes and justify responses (i.e., “What will happen to the cookies when we put them in the oven?”). Only the reasoning level of language abstraction was used during this study.

The modes of response included both receptive and expressive across all levels of abstraction. The assessment described receptive language as a child’s ability to meet those language demands that call for a nonverbal response (i.e., “Show me your shoes.”). The assessment described expressive language as, “a child’s ability to meet those language demands that call for a verbal response” (i.e., “Tell me what’s happening to the glass in these pictures.”) (Blank et al., 2003).

The standardized assessment combined the four different levels of abstraction and two modes of response to develop a total of six subtests that measured the examinee’s discourse skills across. The six subtests were: matching, selective analysis, reordering, reasoning, receptive, and expressive. All components of the PLAI-2 (Blank et al., 2003) were administered to the 16 participants (*N*=16). However, only the reasoning subtest results were used during this study.

The reasoning subtest included 21 test items. The 21 test items were comprised of 10 receptive modes of response and 11 expressive modes of response. For each test item, the examiner was provided with a standardized scoring criterion and list of acceptable responses. A 1 was recorded for correct answers and a 0 for each incorrect answer.

Each participant's (*N*=16) subtest raw score was calculated and then converted to subtest scaled scores, percentile ranks, descriptive ratings, and age equivalents. Subtest scaled scores were based on a normal distribution with a mean of 10 and standard deviation of 3. Descriptive ratings included: very poor (SS: 1-3), poor (SS: 4-5), below average (SS: 6-7), average (SS:8-12), above average (SS:13-14), superior (SS:15-16), and very superior (SS: 17-20).

Participant 6 received a subtest scaled score of 8, average descriptive rating. Participant 11 received a subtest scaled score of 9, average descriptive rating. Participant 7 received a subtest scaled score of 11, average descriptive rating. Participant 13 received a subtest scaled score of 12, average descriptive rating. Participants 1, 3, and 15 received a subtest scaled score of 13, above average descriptive rating. Participants 9 and 10 received a subtest scaled score of 14, above average descriptive rating. Participants 2, 5, and 14 received a subtest scaled score of 16, superior descriptive rating. Participant 16 received a subtest scaled score of 17, very superior descriptive rating. Participant 8 received a subtest scaled score of 18, very superior descriptive rating. Participant 4 and 12 received a subtest scaled score of 19, very superior descriptive rating. See Table 6.

Table 6

PLAI-2 Reasoning Subtest Scaled Scores

Descriptive Term	Very Poor			Poor		Below Average		Average					Above Average		Superior		Very Superior			
Subtest Scaled Score	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
Participant																				
1													X							
2																X				
3													X							
4																			X	
5																X				
6								X												
7											X									
8																		X		
9														X						
10														X						
11									X											
12																			X	
13												X								
14																X				
15													X							
16																	X			

SET Part A: Detection

SET Part A: Detection assessed participants' understanding and use of the visual processing skills called visual constancy and visual discrimination. This section of the authentic assessment included the presentation of three playing cards. The first two cards had stimuli that consisted of either similar or different feature shapes, colors, and number of shapes. The third card was blank. The examiner was required to identify the first two cards by stating their shape, color, and number of shapes. Below the three cards were three answer options. The examiner pointed to each of three answer options while asking the participant to, "Point to the card that completes the SET". The participant responded receptively by pointing to one of the three card options. Correct responses were scored 1 and incorrect responses were scored 0. All 20 test items were administered, regardless of the participant's number of incorrect responses.

The SET authentic assessment did not provide descriptive ratings. However, scores on each section of the SET authentic assessment were described using ranges in percentage of accuracy. Scores out of 20 that fell between 1 and 3 were in the 5%-15% percentage of accuracy category. A score achieved of 4 or 5 fell in the 20%-25%, 6 or 7 fell in the 30%-35%, scores 8-12 fell in the 40%-60%, 13 and 14 fell in the 65%-70%, scores 15 and 16 fell in the 75%-80%, and if a participant scored 17-20 correct responses, they fell in the 80%-100% percentage of accuracy category.

Participant 1, 6, and 15 scored a 9, falling within the 40%-60% percent correct category. Participant 11 scored a 10, falling within the 40%-60% percent correct category. Participant 9, 10, and 16 scored an11, falling within the 40%-60% percent correct category. Participant 3, 8, 12, and 14 scored a 12, falling within the 40%-60% percent correct category. Participants 5, 7, and 13 scored a 13, falling within the 65%%-70% percent correct category. Participant 2 scored a 14, falling within the 65%%-70% percent correct category. Finally, participant 4 received the highest with a score of 15, falling within the 75%%-80% percent correct category. See Table 7.

Table 7

SET Part A: Detection Percentage of Accuracy

Range in % of Scores	5%-15%			20%-25%		30%-35%		40%-60%					65%-70%		75%-80%		85%-100%			
Numerical Score	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
Participant																				
1									X											
2														X						
3												X								
4															X					
5													X							
6									X											
7													X							
8												X								
9											X									
10											X									
11										X										
12												X								
13													X							
14												X								
15									X											
16											X									

Multiple Regression Analysis: PLAI-2 Reasoning Subtest

The second model developed through the use of a multiple regression analysis was PLAI-2 (Blank et al., 2003) Reasoning subtest. The five predictor variables used to predict inferential language (PLAI-2) (Blank et al., 2003) within this model were: SET Detection, SET Completion, SET Detection x SET Detection, SET Completion x SET Completion, and SET Detection x SET Completion. A backward elimination selection procedure model was used to perform regression analyses for each response variable until only statistically significant predictors were included in the model.

A regression analysis was performed for PLAI-2 (Blank et al., 2003) Reasoning subtest scaled scores which yielded the following model. Using the backwards elimination selection procedure model and a hierarchical structure, all predictor variables were present initially and then were removed one at a time until a model that was best fit was selected. Therefore, the first regression analysis performed for PLAI-2 (Blank et al., 2003) Reasoning subtest included all five predictor variables (*DF*=5). See Table 8.

Table 8
PLAI-2 Reasoning Subtest Scaled Score Regression Analysis (N=16)

	Model 5				
	DF	SS	MS	F-Value	P-Value
Regression	5	53.575	10.715	0.98	0.476
Completion	1	0.822	0.8215	0.08	0.79
Detection	1	3.519	3.5188	0.32	0.583
Completion*Completion	1	2.724	2.7243	0.25	0.629
Detection*Detection	1	1.342	1.3421	0.12	0.733
Completion*Detection	1	0.049	0.0492	0	0.948
Error	10	109.425	10.9425		
Total	15	163			
R^2			32.87%		

The final model is illustrated in Table 9. Table 9 gives the analysis of variance for the final model to predict PLAI-2 (Blank et al., 2003) Reasoning subtest scaled scores. The overall model was significant (F1,13=6.06, p=.027). Within this model, results indicated that 30.22% of the variation (R^2=30.22%) in PLAI-2 (Blank et al., 2003) Reasoning subtest scaled scores of kindergarten students at Model School is explained by the linear relationship of PLAI-2 (Blank et al., 2003) Reasoning subtest scaled scores and the SET Part A: Detection percentage scores based on Model 1. The linear term for Detection was also significant with (F1,14=6.06, p=.027), respectfully. The fitted multiple regression model for PLAI-2 (Blank et al., 2003) Reasoning subtest is: Reasoning SSs=2.44+.2031Detection. See Table 9.

Table 9

PLAI-2 Reasoning Subtest Scaled Score Regression Analysis (N=16)

	Model 1				
	DF	SS	MS	F-Value	P-Value
Regression	1	49.26	49.262	6.06	0.027
Detection	1	49.26	49.262	6.06	0.027
Error	14	113.74	8.124		
Total	15	163			
R^2			30.22%		

*p <.05. **p <.01.

Using the fitted multiple regression model for PLAI-2 (Blank et al., 2003) Reasoning subtest scaled scores, scores for the PLAI-2 (Blank et al., 2003) Reasoning subtest were predicted. Table 10 outlines the five prediction regression equations used. The first regression equation indicates 95% confidence that for all students who scored 60% on SET Part A: Detection, the mean PLAI-2 (Blank et al., 2003) Reasoning subtest scaled scores would be between 13.06 and 16.19.

Table 10

Prediction for PLAI-2 Reasoning Subtest

SET Part A: Detection Percentage	95% CI	95% PI	PLAI-2 Reasoning Estimate
60	13.06-16.19	8.32-10.94	14.63
70	14.06-19.26	10.01-23.30	16.66
80	14.53-11.29	11.29-26.08	18.69
90	14.88-26.56	12.26-29.18	20.72
95	15.03-28.44	12.67-30.81	21.74

CHAPTER V

DISCUSSION

This study examined if a correlational relationship exists between different visual perceptual processing skills, inferential language, and phonemic awareness ability. This study aimed to answer the following question: "Is there a statistically significant relationship among visual processing, inferential language, and phonemic awareness ability?" Results from the analyses, clinical implications, limitations, and avenues for future research are discussed within this chapter.

CTOPP-2 Sound Matching Subtest

This study identified that there is a relationship that exists between performance on visual closure tasks and phonemic awareness tasks. Results indicated that participants who performed well on the SET authentic assessment Part B: Completion assessing visual closure also performed well on the CTOPP-2 (Wagner et al., 2013) Sound Matching subtest. This quadratic relationship does not imply causation but does indicate a nonlinear correlation.

Table 4 depicting Model 1 of the CTOPP-2 (Wagner et al., 2013) Sound Matching subtest scaled scores, illustrates the statistical significance found between visual closure tasks and phonemic awareness tasks. After reviewing the same results using Table 1 and 2 and Figure 1, Appendix L, it is understandable how the two sets of scores were found to have a nonlinear correlation.

An important observation is made when examining Figure 2, Appendix L. Figure 2, Appendix L, illustrates how both quadratic and linear variables were found to be significant. Figure 2, Appendix L, illustrates a quadratic effect, until participant 5, 10, and 15 are removed from the sample size. SET Part B: Completion scores for these three participants altered the regression. When removing them from the sample size, a linear relationship between predictor and response variables is established. Further studies using a larger sample size will better answer what type of relationship occurs between phonemic awareness and visual closure.

It should be noted that this study did not examine causation and therefore the reasoning behind the quadratic correlation is unknown at this time. However, some assumptions can be made as to why participants may have similar performance on the two assessments or better performance on one in comparison to the other.

Participants 1, 3, 4, 7, 8, 9, 11, 12, 13, and 16 performed better on the SET Part B: Completion assessment than they did on the CTOPP-2 (Wagner et al., 2013) Sound Matching subtest . When comparing performance using descriptive ratings on the CTOPP-2 (Wagner et al., 2013) Sound Matching subtest and percentage of accuracy on SET Part B: Completion, a majority of the participants scored worse on the phonemic awareness assessment. The difference in performance could be related to a number of variables. Success with nonword reading was predicted by rapid naming, behavior, and home environment (Duff et al. 2008). These three predictors could have easily impacted a participant's performance on the visual processing assessment. In addition, the participant's perception of the visual processing assessment as a form of a game, could have improved their attention, understanding, and motivation to participate.

Performance for participants 2, 6, and 14 happened to be the same on both the SET Part B: Completion assessment and the CTOPP-2 (Wagner et al., 2013) Sound Matching subtest. Similarly, Duff et al. (2008) found that participants within their study who displayed weaknesses in phoneme awareness skills also had difficulties with non-phonological language skills. When children's skill level on phonemic awareness is low, weaknesses in performance on visual tasks may be present as well. Although these three participants did not score low on either assessment, their scores do support the conclusion that one's performance on phoneme awareness tasks will be very similar to their performance on non-phonological language skills (i.e., visual stimuli such as SET).

Participants 5, 10, and 15 performed worse on the SET Part B: Completion assessment than they did on the CTOPP-2 (Wagner et al., 2013) Sound Matching subtest. Although it was non-linear, an overall correlation was present between visual closure tasks and phonemic awareness. The relationship between visual closure and phonemic awareness supports the conclusion that non-phonological oral language skills correlates with word reading accuracy (Duff et al., 2008). The current study identifies an additional non-phonological oral language skill correlating to word reading, visual perceptual processing.

The National Reading Panel (2000) describes phonemic isolation as, "recognizing individual sounds in words" and phoneme identification as, "recognizing the common sound in different words". When completing the phonemic awareness tasks within the

CTOPP-2 (Wagner et al., 2013) Sound Matching subtest, participants were utilizing both phonemic isolation and identification. Participants had to understand that words are broken down smaller units of sound called phonemes. In order for the participant to identify the sound that matches either the beginning or ending sound of the stimulus word, they must first understand that the stimulus is made up of smaller units of sound. After they broke down the word into individual sounds, they were able to identify what the beginning versus middle versus ending sounds were. Knowing the different sounds within the stimulus word allowed the participant to identify which of the answer options started with or ended with the same sound.

When the participant completed the tasks within the SET Part B: Completion authentic assessment, they were utilizing visual closure skills. Just as the participant broke down a word into letters and then individual phonemes during the Sound Matching subtest on CTOPP-2 (Wagner et al., 2013), a breakdown occurred while completing Part B: Completion, separating a SET into cards and then cards into individual features (i.e., color, shape, number). In both cases, the participant had to utilize their visual closure skills to identify how the smaller units play a part in the larger concept.

PLAI-2 Reasoning Subtest

This study identified that there is a linear relationship between performance on visual discrimination/constancy tasks and inferential language tasks. Results indicated that participants who performed well on the SET authentic assessment Part A: Detection, assessing visual discrimination/constancy, also performed well on the PLAI-2 (Blank et al., 2003) Reasoning subtest.

Table 9 depicting Model 1 of the PLAI-2 (Blank et al., 2003) Reasoning subtest scaled scores, illustrates the statistical significance found between visual discrimination/constancy tasks and inferential language tasks. After reviewing Table 6 and 7, as well as Figure 2, Appendix L, it is obvious that a linear correlation is present. There is a common predictive pattern between performances on SET Part A: Detection and PLAI-2 (Blank et al., 2003) Reasoning subtest. On average, participant's performance on the PLAI-2 (Blank et al., 2003) Reasoning subtest either remained the same or improved, when compared to their performance on the SET Part A: Detection.

Participants 6 and 11 performed the same on SET Part A: Detection and PLAI-2 (Blank et al., 2003) Reasoning subtest. It is important to remember that the linear correlation found between inferential language and visual discrimination/constancy does not indicate a causative effect between the two variables. When examining the scores of participant 6 and 11, performance was within the average range on both assessments. It was not expected for them to score higher on PLAI-2 (Blank et al., 2003) Reasoning subtest, just because they scored high on SET Part A: Detection. Success on PLAI-2 (Blank et al., 2003) Reasoning subtest is not determined by success on SET Part A: Detection. However, it was to be hypothesized that the participants would perform well on PLAI-2 (Blank et al., 2003) Reasoning subtest due to scores within the average range on SET Part A: Detection. Results concluded this assumption.

Oral language skills, such as comprehension, prelude the development of reading (Tompkins, Guo, & Justice, 2013). In addition, comprehension skills develop simultaneously with code-related skills in early childhood. With the participants being of age to develop pre-literacy skills, one would expect them to also be developing their code-related skills. The correlation between code-related skills, oral language skills, comprehension, and reading development is strengthened by the results of this study indicating a linear relationship between visual perceptual and language tasks.

However, participants 7 and 13 performed worse on the PLAI-2 (Blank et al., 2003) Reasoning subtest. Results from the PLAI-2 (Blank et al., 2003) Reasoning subtest and SET Part A: Detection, for participant 7 and 13 could have been influenced by participant motivation, administration time, activities they were missing in class, or the difference in test proctors.

Clinton (2015) described the impact of intrinsic and extrinsic motivation on reading processing. Intrinsic motivation is reading in order to gain a meaningful understanding of the text. This form of motivation is positively associated with asking higher-level questions, elaborating, summarizing, inferring word meanings from context, and prediction. Extrinsic motivation, on the other hand, is choosing to read to obtain an external benefit. Research also indicates that the metacognitive awareness of the use of reading strategies was not associated with extrinsic motivation (Clinton, 2015). Participant 7 and 13 could have been extrinsically motivated during the administration of PLAI-2 (Blank et al., 2003) Reasoning subtest, yet intrinsically motivated during the SET Part A: Detection. This would explain why the two participants did not perform as well on the PLAI-2 (Blank et al., 2003) Reasoning subtest.

This study identifies visual discrimination/constancy and inferential language as a linear correlation. Performance on the PLAI-2 (Blank et al., 2003) Reasoning subtest for participants 7 and 13 may be explained by Rayner et al. (2001, 2002) who discovered that in circumstances where an individual demonstrates difficulty using inferential processing, there may be a cognitive overload or breakdown in comprehension (Rayner et al., 2001, 2002). It is reasonable to suspect that participant 7 and 13 were experiencing a cognitive overload or breakdown in comprehension during the completion of PLAI-2 (Blank et al., 2003) Reasoning subtest.

Inferential meaning can be defined as, “that which is not explicitly stated but deduced (presumed) from what is said” (Hegde & Maul, 2006, p. 445) An individual must rely on their past experiences and visual clues when inferring meaning of language, pictures, or scenarios, Participants who performed well on visual discrimination/constancy tasks also performed well on reasoning tasks. The results of this study indicate that one’s visual perceptual skills may play a role in their ability to deduce that which is not explicitly said.

Clinical Implications

The findings of this study have significant implications within the field of speech-language pathology. Specifically, the results from the four assessments and the regression analysis indicate a correlation between phonemic awareness ability and visual closure tasks and inferential language ability and visual discrimination/constancy tasks. Knowing this information impacts the necessity for awareness of visual processing within the field of speech-language pathology, intervention practices focusing on visual processing, education and training of SLPs on visual processing development, skills, and abilities, and avenues for future research examining additional roles of visual processing within the field of speech-language pathology.

There lacks a prevalence of research describing the role of visual processing within the field of speech-language pathology; specifically, the role of visual processing during language instruction and reading development. As previously stated in this paper, there is a vast amount of research identifying a strong relationship exists between phonemic awareness and reading (Stahl & McKenna, 1994) and between inferential language and reading comprehension (Cain & Oakhill, 1999). However, limited research examining the relationship between visual processing and other skills associated with reading ability exists. This study found evidence that explored the significance of visual processing with reading ability. Within the current study's results, scores on phonemic awareness tasks were correlated with scores on visual closure tasks (R^2=50.44%) and scores on inferential tasks were correlated with scores on visual constancy and discrimination tasks (R^2=30.22%).

Finding an effect of visual processing skills on pre-literacy skills may lead to the need for SLPs to increase their awareness of visual perceptual processing deficits during the referral, evaluation, and intervention process of disorders related to pre-literacy development. Some clients who score poorly on assessments examining pre-literacy skills may also need to be assessed by an OT or optometrist for visual perceptual processing deficits. In the same way, other professionals will need to be aware of possible language deficits that may be present if visual perceptual processing deficits are evident.

In addition to the awareness of visual processing skills within language, SLPs may also need to complete further education and training in this area. Visual therapy and training is currently being provided by optometrists and occupational therapists. Although the research and regulations do not allow visual therapy to be provided by SLPs, these professionals need to understand what visual processing is and how it impacts their field of study. It is important to be educated on what things may be red flags for visual processing disabilities or deficits and who to contact for assistance. In doing so, they will be able to adequately provide support and aid to their clients in all areas of possible developmental deficits/delays.

When providing intervention for pre-literacy skills, specifically phonemic awareness and inferential language, an SLP may consider implementing visual processing tasks to strengthen language growth and development. This study found that scores on visual closure tasks were correlated to scores on phonemic awareness tasks (R^2=50.44%). Visual closure tasks similar to those presented in Part B: Completion of the SET authentic assessment, requiring participants to identify what picture and/or object is needed to complete the stimulus, may be beneficial during instruction on phonemic awareness.

Similarly, visual discrimination and constancy skills may be beneficial during instruction on inferential language. This study found that scores on visual discrimination and constancy tasks were correlated to scores on inferential language tasks (R^2=30.22%). During intervention for reasoning, SLPs could present items similar to those presented in

Part A: Detection of the SET authentic assessment, requiring participants to identify what characteristics are similar and different between pictures and/or objects.

Limitations

After completing the study and analyzing the method, data collection, and regression analyses, there were some limitations noted that could have impacted the results. (1) The small sample size increased the margin of error and made each regression analysis more difficult to complete/less reliable. (2) The amount of parameters/predictor variables selected in relation to the number of participants could have weakened the precision of estimated regression coefficients. This value decreases as more predictors are added to the model. (3) The fact that one assessment was presented in a similar format as a game, could have effected how the participants reacted to it in comparison to the other two assessments. Some participants may have taken the CTOPP-2 (Wagner et al., 2013) Sound Matching subtest and PLAI-2 (Blank et al., 2003) Reasoning subtest more seriously than the SET authentic assessment. (4) The time at which the participants were administered the three separate assessments could have also impacted the results. Each participant was removed from their classroom on two separate occasions in order to complete all three assessments. Participants were available at different intervals of time, depending upon their daily class schedule. A difference in when each student was administered the different assessments could have altered their fatigue and attention levels. (5) High multicolinearity levels strengthened the notion that there is on overall correlation between all variables involved but weakened the conclusion that strong correlations exist between specific variables. (6) The three participants (5, 10, and 15) who scored poorly on the SET Part B: Completion altered the type of relation identified in this study. Having a larger sample size could have resulted in a more linear correlation rather than quadratic. (7) A number of participants within this study were not within the age range that the PLAI-2 (Blank et al., 2003) Reasoning subtest was normed on, at the time of this study. Following interpretation of scores, the results of the PLAI-2 (Blank et al., 2003) Reasoning subtest for these specific participants may not have been accurately represented by this assessment.

Avenues for Future Research

Subsequent research using a larger sample size is warranted to document a greater correlational relationship between variables. Further studies may look at one specific visual processing skill in relation to one language skill, thus reducing the ratio of predictor variables against response variables. If the larger sample size and fewer parameters prove to show a greater relationship between variables, further research studies will need to investigate the effect of visual processing instruction within inferential language and phonemic awareness intervention. With the vast amount of assessment data collected within this study, it could yield the need for future studies examining the participant's performance on SET against other subtests of the PLAI-2 (Blank et al., 2003) and CTOPP-2 (Wagner et al., 2013) that were not examined within this study. If a larger sample size strengthens the results from this study by finding a quadratic relationship between phonemic awareness and visual closure, further studies will need to examine the reason for such correlation. A qualitative study could examine what SLPs current perception and practice is regarding collaboration between SLP's and

OT's during phonemic awareness, inferential language, and/or visual processing instruction. Additionally, a longitudinal study may prove to be beneficial in describing the undocumented impact of visual processing skills within literacy development over a period of time.

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APPENDIX A:

Definitions: Visual Processing Skills

TASK	**EXPLANATION** (Andrich et al., 2015).	**PROBLEMS WITH:** (Kurtz, 2006)
Visual Spatial Relations	"The ability to determine that one form or part of a form is turned in a different direction that the others."	"Difficulty differentiating between, /b/, /d/, /p/, and /q/."
Visual Sequential Memory	"The ability to remember a series of forms and find it among four other series of forms; reflects a child's ability to recall a series or sequence of forms."	"Ability to sequence letters or numbers in words or math problems. Difficulty remembering the alphabet."
Visual Discrimination	"The ability to differentiate between objects and forms. It gives us the ability to notice subtle differences and to identify if something does or does not belong."	"Discriminating between size of letters and objects, similarities and differentness in the formation of letters or objects, or correcting errors in school work."
Visual Form Constancy	"The ability to see a form and find it among other forms, although it may be sized different or rotated; reflects a child's ability to recognize forms, letters, or words regardless of their orientation."	"Difficulty recognizing familiar letters when presented in different styles of print, difficulty recognizing errors, confusion between "/p/, /q/, and /g/", "/a/ and /o/", and "/b/ and /d/"."
Visual Memory	"The ability to store visual details of what has been seen in the short-term memory."	"Difficulty reproducing figures, comprehending reading, remembering sight words, replicating information on worksheets and tests."
Visual Closure	"The ability to look at an incomplete shape, object, or amount, and fill in the missing details in order to identify what it would be if it were complete."	"Difficulty spelling, writing, solving puzzles, completing dot-to-dot worksheets or puzzles. Often leaves out parts of words or entire words."
Visual Figure Ground	"The ability to perceive a form and find it hidden in a conglomerated ground of matter; ability to locate and identify shapes and objects embedded in a busy visual environment; ability to attend to one activity without being distracted by other surrounding stimuli."	"Difficulty attending to a word on a printed page, filtering out visual distractions such as colorful bulletin boards or movement, and over attends to details and misses "big picture". Difficulty recognizing misformed letters."

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APPENDIX B:

Definitions: Phonemic Awareness Tasks

TASK	EXPLANATION	EXAMPLE
Phoneme Isolation	"Recognizing individual sounds in words."	"Tell me the first sound in bat." (/b/)
Phoneme Identification	"Recognizing the common sound in different words."	"Tell me the sound that is the same in cat, cow, and coffee." (/c/)
Phoneme Categorization	"Recognizing the word with the odd sound in a sequence of three or four words."	"Tell me what word does not belong. boy, bus, cat." (cat)
Phoneme Blending	"Listening to a sequence of separately spoken sounds and combining them to form a recognizable word."	"Tell me what word you hear when you combine these sounds, /r/ /u/ /g/." (rug)
Phoneme Segmentation	"Requires breaking a word into its sounds by tapping out or counting the sounds or by pronouncing and positioning a marker for each sound."	"Tell me how many sounds/phonemes are in the word hit." (Three: /h/ /I/ /t/)
Phoneme Deletion	"Recognizing what word remains when a specified phoneme is removed."	"Tell me what word we make if take away the /s/ from small." (mall)
Phoneme Addition	"Recognizing what word is created when a specified phoneme is added."	"Tell me what word we make if we add /s/ to the beginning of mall." (small)
Phoneme Substitution	"Recognizing what word is created when a specified phoneme is removed and replaced with a different phoneme."	"Tell me what word we make when we switch the /m/ in the word small with the letter /t/." (stall)

Source: National Reading Panel (U.S.), & National Institute of Child Health and Human Development (U.S.). (2000). *Teaching children to read: An evidence-based assessment of the scientific research literature on reading and its implications for reading instruction: reports of the subgroups*. Retrieved from: http://books.google.com/books?id=b0WdAAAAMAAJ

APPENDIX C:

Model Laboratory School Release

EASTERN KENTUCKY UNIVERSITY
Serving Kentuckians Since 1906

Ann Burns, EdD
Interim Director
Model Laboratory School
http://model.eku.edu/

College of Education
521 Lancaster Avenue
Richmond, Kentucky 40475-3102
(859) 622-3766

Letter of Agreement

July 1, 2016

Dear Leanna Rowlette,

I have reviewed the study design and the objectives of your research project titled *Visual Processing Ability: Early Predictor of Inferential Language and Phonemic Awareness Ability.* This letter is to affirm that I understand the role of Model Laboratory School and agree to allow data collection to occur during the 2016 -2017 school year of students in kindergarten.

I understand the role that the school and its' students would have in this research study and I am satisfied that their safety and welfare are adequately protected. In addition, I understand that this research will be carried out following sound ethical principles and that participation in this study is voluntary. Furthermore, participant's privacy will be guaranteed to the best of the study's ability.

Therefore, I agree to allow Leanna Rowlette, under the guidance of her Master's committee consisting of Dr. Kellie Ellis, Dr. Sue Mahanna-Boden, Dr. Michelle Gemp, Dr. Michelle Smith, and Mrs. Cindy Reeves, to conduct research at the school for the 2016 -2017 school year. I understand that data collection will consist of interactions within the Kindergarten classrooms. Furthermore, I understand that this research will involve multiple data collection points from participating students through the identified assessments in the Internal Review Board (IRB) application. The assessment will take approximately fifty minutes per student and will occur at a time and place agreed to by the kindergarten teacher(s) in order to impact as minimally as possible the academic goals of the students.

I understand that this research will only take place once approval has been gained through the Eastern Kentucky University's Internal Review Board (IRB) with Authorization Agreement provided by Eastern Kentucky University's IRB.

Sincerely,

Ann H. Burns

Ann H. Burns, EdD
Interim Director
Model Laboratory School

Kentucky UNBRIDLED SPIRIT

APPENDIX D:

Recruitment Letter

EASTERN KENTUCKY UNIVERSITY
Visual Processing Ability: Early Predictor of
Inferential Language and Phonemic Awareness Ability

August 2, 2016

Dear Parent/Guardian,

I am writing to let you know about an opportunity your child has been given to participate in a research study about visual processing. The study is being conducted by Leanna Rowlette, graduate student in the Communication Disorders program at Eastern Kentucky University, and Dr. Kellie C. Ellis, Program Coordinator/Associate Professor for the Communication Disorders program at Eastern Kentucky University. The study will use scores obtained on three assessments to identify if visual processing is a predictor of inferential language and phonemic awareness. This study is significant because knowledge of pre-requisite reading skills and the factors impacting the development of such skills will aid in the instruction and development of later reading ability and success. This study hopes to examine the predictability of visual processing on other necessary skills during reading.

Your child has recently been given a developmental screener at Model Laboratory School. Following analysis of your child's scores on the developmental screener by Model Laboratory school staff, along with your child meeting the inclusion criteria (between the age of 3 year, 0 month and 5 year, 11 month, passed a hearing and vision screener, speaks English in the home, and has no history of a disorder or disability), he or she has been identified as a perspective participant in the study.

The study will include administering three assessments to your child: SET Ability authentic assessment (SET Enterprises Inc.), Comprehensive Test of Phonological Processing (CTOPP-2), (Wagner, Torgesen, Rashotte, & Pearson, 2013) and the Preschool Language Assessment Index (PLAI-2), (Blank, Rose, & Berlin, 2003). An authentic assessment will be used to determine your child's set ability. The assessment will have two parts: Part A and Part B. Part A will measure SET detection and Part B will measure SET Completion. The Preschool Language Assessment Index (PLAI-2), (Blank, Rose, & Berlin, 2003) will be administered to assess your inferential language ability. The assessment conists of four subtests (mathcing, analysis, reordering, reasoning) and a composite score. The Comprehensive Test of Phonological Processing (CTOPP-2), (Wagner, Torgesen, Rashotte, & Pearson, 2013) will be administered to determine the your child's phonemic awarness ability. The study will only use one subtest from the assessment (sound matching). The three assessments will take approximately 50 minutes split between two sessions. The study will take place at Model Elementary school. It is estimated that the three assessments will be administered. There are no known risks of the proposed study.

Your child’s participation is confidential and voluntary and he/she is free to answer any questions they would like, to withdraw his/her assent and/or to discontinue participation at any time without penalty.

If you decide to provide permission for your child to volunteer to participate in this study, please return a signed consent formed to your child’s kindergarten teacher. Upon receiving the signed consent form a copy will be mailed back to you and an assent form will be provided to your child.

If you have any questions or concerns about the research, please feel free to contact Leanna Rowlette at: (E-mail) leanna_rowlette2@mymail.eku.edu, (Phone) 859-302-1804. You may also contact Dr. Kellie Ellis at: (Department) Communication Disorders, (Office) Wallace 204, (Address) Wallace 245, (E-mail) kellie.ellis@eku.edu, (Phone) 859-622-1860.

Enclosed is a copy of the consent form which gives you more information on the study. If you are interested in providing permission for your child to participate in this study, please send the signed consent form to your child’s kindergarten teacher. I greatly appreciate your help.

Sincerely,

Leanna Rowlette

APPENDIX E:

Informed Consent Form

Consent to Participate in a Research Study

Visual Processing Ability: Early Predictor of Inferential Language and Phonemic Awareness Ability

Why is my child being invited to take part in this research?
Your child is being invited to take part in a research study about visual processing ability and its ability to predict inferential language ability and phonemic awareness ability. Your child is being invited to participate in this research study because he or she met the following inclusion criteria: your child is between the age of 3 year, 0 month and 5 year, 11 month; has passed a visual and hearing screener, speaks English as the primary language in their household, and must not possess any disorder or disability.

Who is doing the study?
The person in charge of this study is Leanna Rowlette a second-year graduate student at Eastern Kentucky University. She is being guided in this research by Dr. Kellie Ellis. There may be other people on the research team assisting at different times during the study.

What is the purpose of the study?
By doing this study, we hope to learn if one's visual processing ability predicts their inferential language and phonemic awareness ability.

Where is the study going to take place and how long will it last?
The research procedures will be conducted at Model Laboratory School. The study will take one to two days to complete and will require approximately 50 min. of your child's time.

What will my child be asked to do?
During the study, your child will be administered thre assessments: SET Ability authentic assessment (SET Interprises Inc.), Comprehensive Test of Phonological Processing (CTOPP-2), (Wagner, Torgesen, Rashotte, & Pearson, 2013) and the Preschool Language Asessment Index (PLAI-2), (Blank, Rose, & Berlin, 2003).

Are there reasons why my child should not take part in this study?
Children who are not within the age range of 3 year, 0 month and 5 year, 11 month, do not pass the developmental screener, do not successfully complete a

hearing and visual screener, do not speak English as the primary language, and those who have a disorder or disability.

What are the possible risks and discomforts?
There are no known risks of the study.

Will my child benefit from taking part in this study?
Your child will not get any personal benefit from taking part in this study.

Does my child have to take part in this study?
If you decide to allow your child to take part in the study, it should be because your child really wants to volunteer. Your child will not lose any benefits or rights they would normally have if you choose not to allow them to take part in the study. Your child can stop at any time during the study and still keep the benefits and rights you had before volunteering.

If I don't want my child to take part in this study, are there other choices?
If you do not want your child to take part in the study, there are no other choices except to not take part in the study.

What will it cost for my child to participate?
There are no costs associated with taking part in this study.

Will my child receive any payment or rewards for taking part in the study?
Your child will not receive any payment or reward for taking part in this study.

Who will see the information I give?
Your child's information will be combined with information from other people taking part in the study. When we write up the study to share it with other researchers, we will write about this combined information. Your child will not be identified in these written materials.

We will make every effort to prevent anyone who is not on the research team from knowing that you gave us information, or what that information is. For example, your name will be kept separate from the information you give, and these two things will be stored in different places under lock and key.

However, there are some circumstances in which we may have to show your information to other people. For example, the law may require us to show your information to a court or to tell authorities if we believe you have abused a child or are a danger to yourself or someone else. Also, we may be required to show information that identifies you to people who need to be sure we have done the research correctly; these would be people from such organizations as Eastern Kentucky University.

Can my child's taking part in the study end early?
If your child decides to take part in the study, he or she still have the right to decide at any time that he or she no longer wants to participate. Your child will not be treated differently if he or she decides to stop taking part in the study.

The individuals conducting the study may need to end your child's participation in the study. They may do this if your child is not able to follow the directions they give him or her, if they find that your child being in the study is more risk than benefit to him or her, or if the agency funding the study decides to stop the study early for a variety of scientific reasons.

What happens if my child gets hurt or sick during the study?
If your child believes he or she is hurt or if your child gets sick because of something that is done during the study, you should call Leanna Rowlette at 859-302-1804 immediately. It is important for you to understand that Eastern Kentucky University will not pay for the cost of any care or treatment that might be necessary because your child gets hurt or sick while taking part in this study. That cost will be your responsibility. Also, Eastern Kentucky University will not pay for any wages your child may lose if you are harmed by this study.

Usually, medical costs that result from research-related harm cannot be included as regular medical costs. Therefore, the costs related to your child's care and treatment because of something that is done during the study will be your responsibility. You should ask your insurer if you have any questions about your insurer's willingness to pay under these circumstances.

What if I have questions?
Before you decide whether to accept this invitation for your child to take part in the study, please ask any questions that might come to mind now. Later, if you have questions about the study, you can contact the investigator, Leanna Rowlette at 859-302-1804. If you have any questions about your child's rights as a research volunteer, contact the staff in the Division of Sponsored Programs at

Eastern Kentucky University at 859-622-3636. We will give you a copy of this consent form to take with you.

What else do I need to know?
You will be told if any new information is learned which may affect your condition or influence your willingness to continue taking part in this study.

I have thoroughly read this document, understand its contents, have been given an opportunity to have my questions answered, and give permission for my child to participate in this research project if he/she chooses to participate.

____ __________________
Signature of person agreeing to take part in the study Date

____
Printed name of person taking part in the study

____
Name of person providing information to subject

APPENDIX F:

Assent Form

Assent Form for Child's Participation in a Research Project
(for children under the age of 7)

Visual Processing Ability: Early Predictor of Inferential Language and Phonemic Awareness Ability

I am conducting research to find what skills are necessary for reading development and would like your help because you are a kindergartener, passed the developmental screener at Model, you can see and hear well, and because you speak English at home, and have no history of a disorder or disability.

If you choose to help me you will get to do three fun activities. The first acitivity is called SET Game and consists of two parts. For the first part of the activity, you will be shown three cards and asked if there is a pattern (SET). During the second part, you are shown two cards that have different shapes that are different colors and ask to choose the third card to finish the pattern. The second activity is called the Preschool Language Assessment Index (PLAI-2), (Blank, Rose, & Berlin, 2003). During this activity you are asked different questions about pictures I will show you and asked to choose your best answer. The last activity is called the Comprehensive Test of Phonological Processing (CTOPP-2), (Wagner, Torgesen, Rashotte, & Pearson, 2013). This time, I will read different words and you will tell me if the words have similar sounds. If you decide to participate in this research study, I will examine your work from each activity to see if your ability on the SET Game predicts your ability on the other two activities.

If you decide to participate in this project, you will be asked to participate in three assessments, testing your visual processing ability, inferential language ability, and phonemic awareness ability.

Your parents know that I am asking you if you want to participate, but it is up to you to decide if you want to do this. You should not feel pressured to participate, and no one will be upset with you if say no. Even if you say yes now but decide you want to stop later, no one will be upset with you. All you have to do is tell me that you want to stop.

There aren't any known risks from participating in this study.

If you want to participate, you can write your name on the line below. If you have any questions, please ask me before you sign. If you do not want to participate, please do not write your name.

Child's Signature	Date	Witness Signature	Date

APPENDIX G:

Protection of Pupil Rights Amendment [PPRA] Form

PPRA Notice and Consent

The Protection of Pupil Rights Amendment (PPRA), 20 U.S.C. § 1232h, requires **Eastern Kentucky University and its Model Laboratory School** to notify you and obtain consent or allow you to opt your child out of participating in certain school activities. These activities include a student survey, analysis, or evaluation that concerns one or more of the following eight areas ("protected information surveys"):

1. Political affiliations or beliefs of the student or student's parent;
2. Mental or psychological problems of the student or student's family;
3. Sex behavior or attitudes;
4. Illegal, anti-social, self-incriminating, or demeaning behavior;
5. Critical appraisals of others with whom respondents have close family relationships;
6. Legally recognized privileged relationships, such as with lawyers, doctors, or ministers;
7. Religious practices, affiliations, or beliefs of the student or the student's parent; or
8. Income, other than as required by law to determine program eligibility.

This parental notification requirement and opt-out opportunity also apply to the collection, disclosure or use of personal information collected from students for marketing purposes ("marketing surveys"). Please note that parents are not required by PPRA to be notified about the collection, disclosure, or use of personal information collected from students for the exclusive purpose of developing, evaluating, or providing educational products or services for, or to, students or educational institutions. Additionally, the notice requirement applies to the conduct of certain physical exams and screenings. This includes any non-emergency, invasive physical exam or screening required as a condition of attendance, administered by the school or its agent, and not necessary to protect the immediate health and safety of a student. This does not include hearing, vision, or scoliosis screenings, or any physical exam or screening permitted or required by State law.

The following activity requires parental notice and consent and Eastern Kentucky University and Model Laboratory School will provide parents, within a reasonable period of time prior to the administration of the survey, an opportunity to opt their child out, as well as an opportunity to review the survey.

Date: On or about October 1, 2016
Grades: 3 year, 0 month to 5 year, 11 month
Activity: Visual Processing Ability: Early Predictor of Inferential Language and Phonemic Awareness Ability
Summary: This study looks to examine the predictability of visual processing on prerequisite skills needed for reading acquisition. Participants who are chosen and

volunteer to participate in the study will complete three assessments split between two sessions, taking an average of 50 minutes each. The three assessments are: SET Ability authentic assessment (SET Enterprises Inc.), Comprehensive Test of Phonological Processing (CTOPP-2), (Wagner, Torgesen, Rashotte, & Pearson, 2013) and the Preschool Language Assessment Index (PLAI-2), (Blank, Rose, & Berlin, 2003).

Consent: A parent must sign and return the consent below no later than _______________so that your child may participate in this survey.

I ________________________ (parent's name) give my consent for _____________________(child's name) to take the __________________________ (describe project) survey on or about ____________________________ (date).

____
Parent's signature

Please return this form to the following school official:

APPENDIX H:

Student Authorization to Release Academic/Educational Records

STUDENT AUTHORIZATION TO
RELEASE ACADEMIC/EDUCATIONAL RECORDS

Pursuant to the Family Educational Rights and Privacy Act (FERPA, aka the Buckley Amendment), I, ____________________ *(printed name of student)*, with an address of ______________________________ *(street, city, state and zip code)*, do hereby authorize Eastern Kentucky University and its Model Laboratory School (collectively, "EKU"), as well as its officers, agents, employees, and/or faculty, to release to and/or discuss with Leanna Rowlette (Student) Dr. Michelle Smith (Statistical Consulting Center) Dr. Kellie Ellis (Faculty Advisor) *(printed name of individual or entity to whom records may be released)*, whose address is EKU 204 Wallace Building, 521 Lancaster Ave. Richmond Ky 40475 *(street, city, state and zip)*, the following information and/or records *(please initial the selected option)*:

______ any and all educational records maintained by EKU relating to my educational career at EKU, including academic records, billing/student account records, financial aid records, etc. for the entire period of my attendance at EKU.
OR

______ any and all educational records maintained by EKU relating to my educational career at EKU, including academic records, billing/student account records, financial aid records, etc. for ____________________ *(specify a time period)* only.
OR

______ records and information described as follows, including time period of information/records: Model Laboratory School Developmental Screener, SET Ability assessment scores, The Preschool Language Assessment Index scores, The Comprehensive Test of Phonological Processing

This authorization is effective *(please initial selected option)*:

______ until revoked by me in writing.
OR

______ from the date of this authorization through: May 1, 2017 *(indicate specific expiration date)*

____

Printed Name and Signature of Student or Parent/Legal Guardian (if student is a minor) Date

____

Student Date of Birth Student Identification Number OR SSN

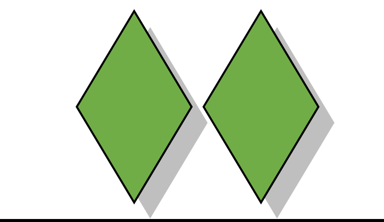
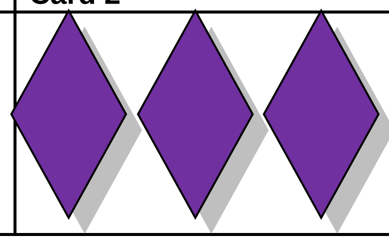
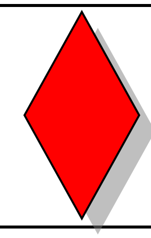
00061036-1

APPENDIX I:

SET Authentic Assessment: Part A

Examiner Side:

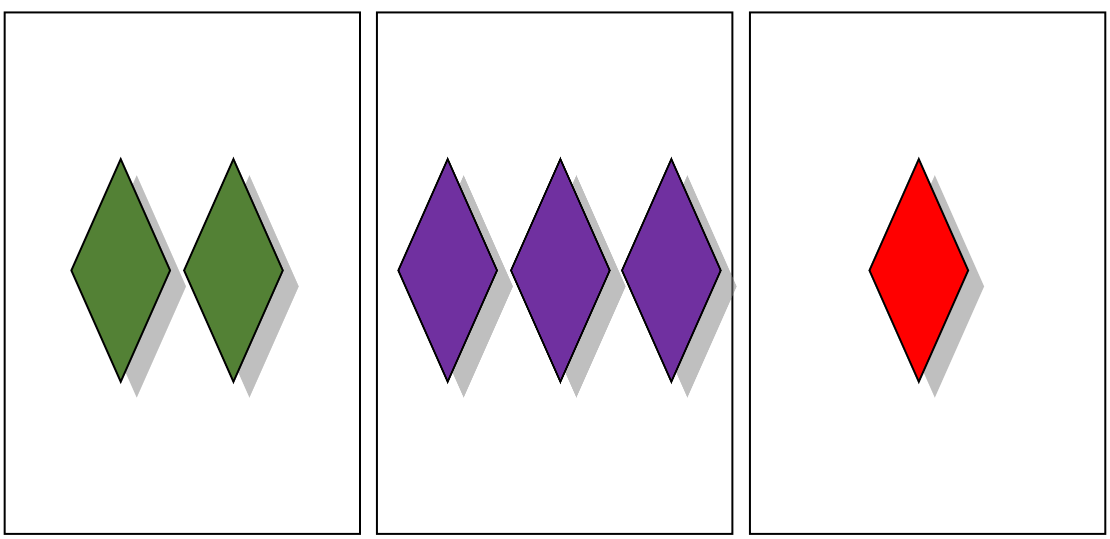
Set Game Test Script – Part A

Stimulus #2		
Card 1	**Card 2**	**Card 3**
		

Examiner:

The first card has two, green, diamonds.
The second card has three, purple, diamonds.
The third card has one, red, diamond.
Is this a SET?

Examinee Side:

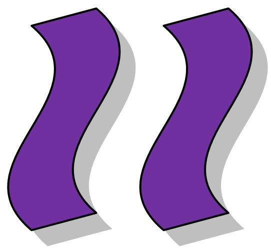
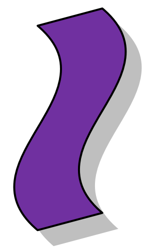


APPENDIX J:

SET Authentic Assessment: Part B

Examiner Side:

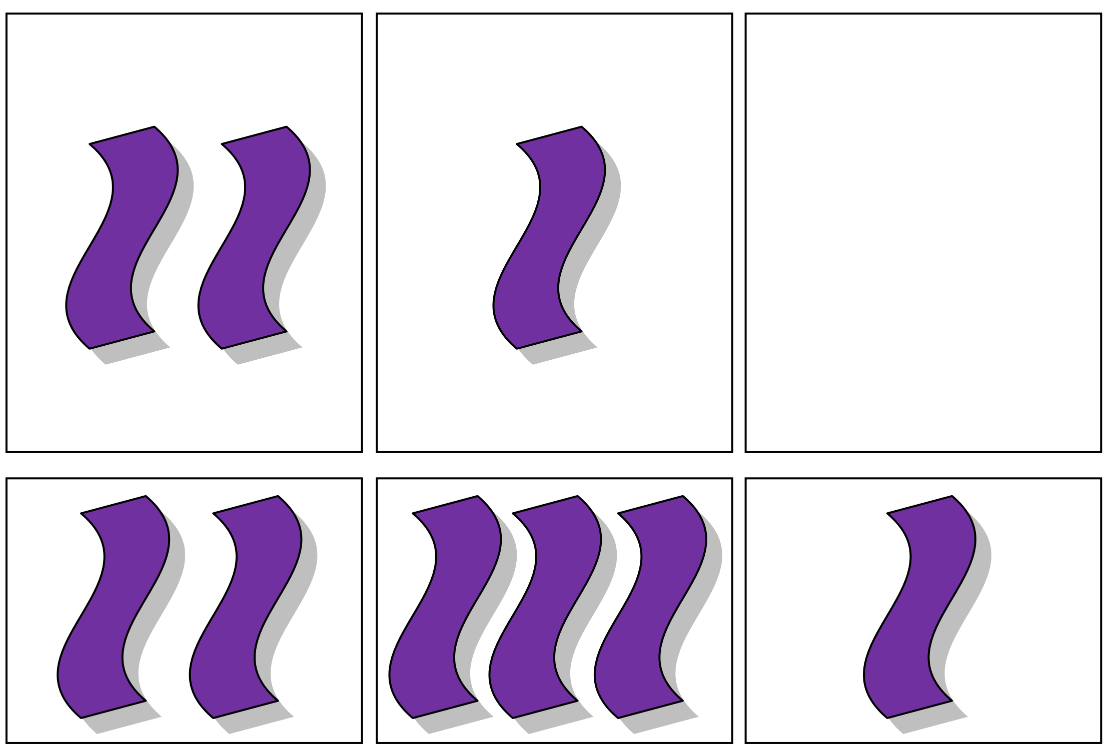
Set Game Test Script – Part B

Stimulus #5		
Card 1	**Card 2**	**Card 3**
		**?**

Examiner States:

The first card has two, purple, squiggles.
The second card has one, purple, squiggle.
Point to the card that completes the SET.

Examinee Side:



APPENDIX K:

SET Authentic Assessment: Scoring Sheet

The Set Game – Scoring Sheet

Name **Date** **Birthday**

Part A – Detection			
Stimuli	**Response**		**Accuracy**
1	YES	NO	
2	YES	NO	
3	YES	NO	
4	YES	NO	
5	YES	NO	
6	YES	NO	
7	YES	NO	
8	YES	NO	
9	YES	NO	
10	YES	NO	
11	YES	NO	
12	YES	NO	
13	YES	NO	
14	YES	NO	
15	YES	NO	
16	YES	NO	
17	YES	NO	
18	YES	NO	
19	YES	NO	
20	YES	NO	
		Total	**/ 20**

Part B – Completion					
Stimuli	**Response**			**Accuracy**	
1	A	B	C		
2	A	B	C		
3	A	B	C		
4	A	B	C		
5	A	B	C		
6	A	B	C		
7	A	B	C		
8	A	B	C		
9	A	B	C		
10	A	B	C		
11	A	B	C		
12	A	B	C		
13	A	B	C		
14	A	B	C		
15	A	B	C		
16	A	B	C		
17	A	B	C		
18	A	B	C		
19	A	B	C		
20	A	B	C		
				Total	**/ 20**

APPENDIX L:

Figures

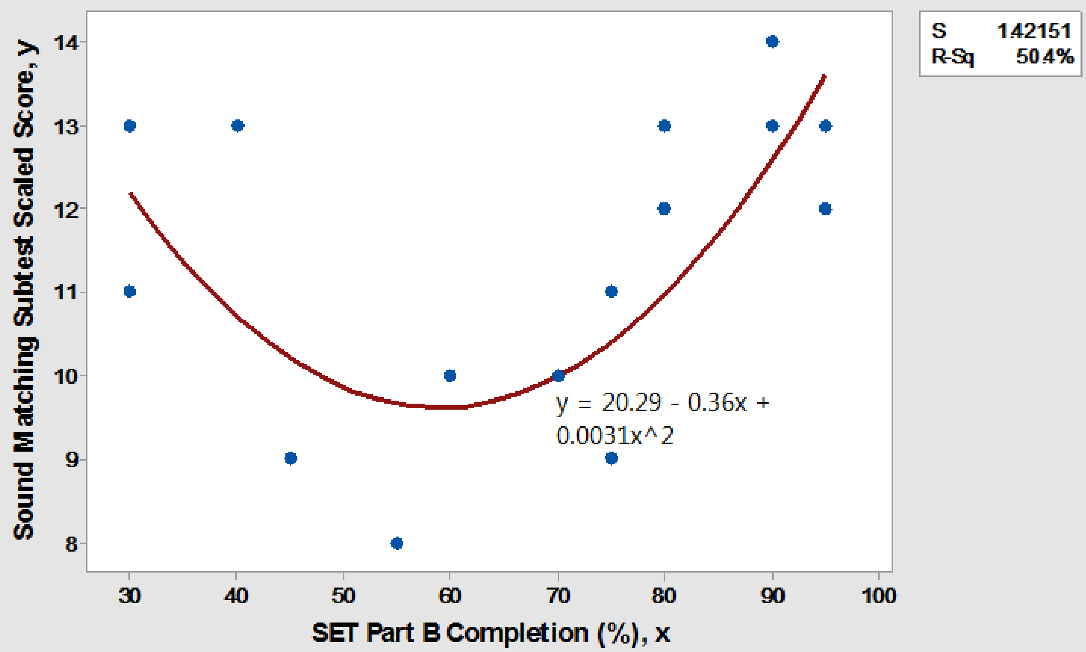


Figure 1. Relationship Between Sound Matching Subtest Scaled and SET Part B Completion (%)

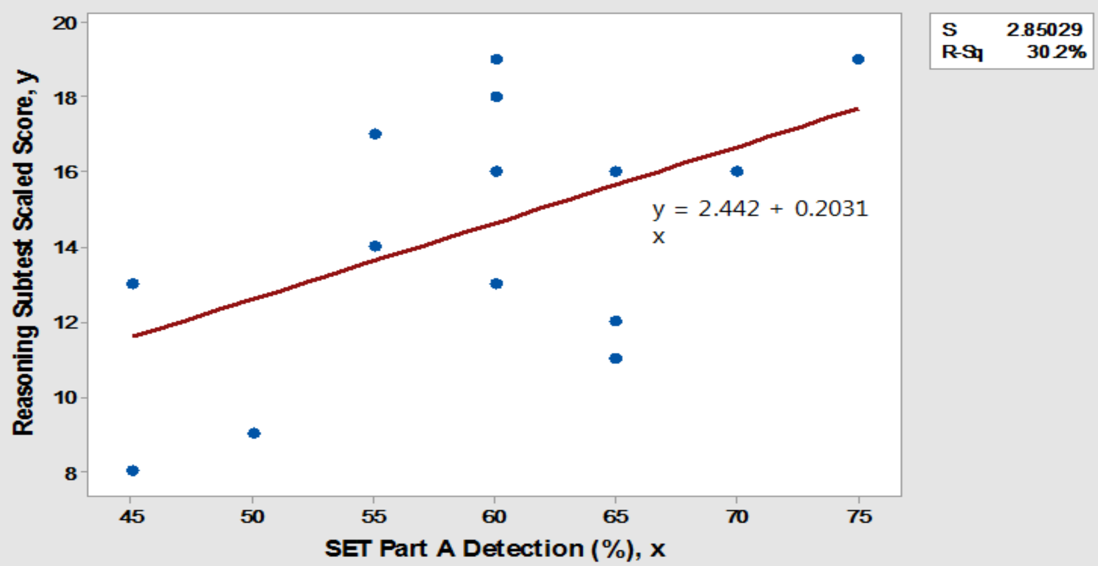


Figure 2. Relationship Between Reasoning Subtest Scaled Score and SET Part A Detection (%)