SEASON OF BIRTH AND READING PROBLEMS

by

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(Under the Direction of Paula Schwanenflugel)

ABSTRACT

Research investigating seasonal birth patterns and various psychological, educational, and/or social phenomena has for some time included the "summer birthday" issue in children's early academic achievement. Specifically, there has been evidence that children born in the summer seem to be at an academic disadvantage – at least during early elementary school years – relative to children born at other times of the year. Several possible explanations for this phenomenon have been described in the literature, including those involving maturational and self-concept issues. The current study compared standardized reading test scores and birth patterns of approximately 1100 first, second, and third graders from Georgia and New Jersey. It was hypothesized that the students with summer birthdays (i.e., those in June, July, or August) would systematically show lower test scores on the reading measure compared to their fall, winter, or spring birthdate peers. The hypothesis was not supported; indeed, the results showed that students with fall birthdays obtained the lowest scores. Potential explanatory variables are discussed, as are the extant difficulties inherent in research of this type – including those that are a function of a given test's norms.

INDEX WORDS: Season of birth, reading achievement, dyslexia, relative age

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CHAPTER 1

INTRODUCTION AND RATIONALE

Over the last several decades, research has been accumulating which demonstrates that persons with a broad array of neuropsychological disorders or abnormalities show birth patterns that differ from those of the general population. There is also a growing body of evidence that children with certain academic problems (e.g., learning disabilities) show distinct birth patterns. Collectively, these phenomena are often referred to as *season of birth research.*

From an academic perspective, this notion has several implications. When considering the learning tasks deemed most important during the beginning school years, one is hard-pressed to find an academic skill whose acquisition is more crucial than that of reading. Reading is undoubtedly the most critical academic skill children will learn and one of the best predictors of overall success in school (Stanovich, 1986) and society (Lyon, 1997). Research suggests that first-grade students who experience reading difficulties are likely to continue having problems in that area (Torgesen, 1998), and a large percentage of third graders who have below average reading skills will continue to have difficulties in the ninth grade (Lyon, 1995). Further, evidence has shown that poor readers tend to become poor writers (Chall & Jacobs, 1983; Juel, 1988). Adding to this concern is the evidence suggesting that approximately 80% of students diagnosed with learning disabilities struggle with reading (Lyon, 1995) and many children diagnosed with emotional/behavioral disorders experience reading problems as well (Coleman, 1996). Poor academic achievement, much of which is caused by poor reading skills, is also correlated with behavior problems throughout childhood and adolescence (McEvoy & Welker, 2000), and this association strengthens during the elementary school years (Hinshaw, 1992).

There is a great deal of evidence indicating that the development of reading fluency is vital to overall academic achievement. Reading fluency is believed to comprise various subskills, including sight word recognition and phonemic decoding. Several models exist which help elucidate the relationship between these two fundamental skills, and research has been quite consistent in supporting the notion that both are critical in a child's reading acquisition. In this respect, the assessment of such skills should provide a useful gauge of a child's early reading progress.

There is evidence demonstrating that summer-born children are more likely to experience academic difficulties and, more specifically, learning disabilities. This body of research is growing but still small, and the number of studies specifically evaluating seasonal birth patterns and reading achievement is even less. Such inquiry involves recognition of numerous problematic issues that arise when considering reading assessment and season of birth phenomena. However, there is potential benefit in such efforts, even if it involves solely the identification of new questions and confounds relevant to future investigations.

CHAPTER 2

REVIEW OF THE LITERATURE

Reading is arguably one of the most discussed educational topics in America. Over the last several decades, children who experience significant and persistent reading difficulties have been characterized by a number of different labels, including *dyslexia, word blindness,* or *specific reading disability.* Dyslexia is derived from the Greek *dys,* meaning difficult or hard, and *lexia,* which refers to words. In 1968, the World Federation of Neurology offered the following "official" definition of dyslexia (as summarized by Critchley, 1970):

> "A disorder manifested by the difficulty in learning to read, despite conventional instruction, adequate intelligence and sociocultural opportunity. It is dependent upon fundamental cognitive disabilities, which are frequently of constitutional origin" (p. 11).

The definition offers little in terms of the actual characteristics of dyslexia and instead provides mostly exclusionary criteria. As such, dyslexia appears to encompass all the reading problems that cannot be explained (Høien, 2001). More recently, the National Institutes of Health and the International Dyslexia Association adopted the following definition, which is more proactive in its characterization of dyslexia:

> "Dyslexia is a specific learning disability that is neurological in origin. It is characterized by difficulties with accurate and/or fluent word recognition and by poor spelling and decoding abilities. These difficulties typically result from a deficit in the phonological component of language that is often unexpected in relation to other cognitive abilities and the provision of effective classroom instruction. Secondary consequences may include problems in reading comprehension and reduced reading experience that can impede growth of vocabulary and background knowledge" (Lyon, Shaywitz, & Shaywitz, 2003, p. 1).

With its emphasis on accurate and fluent word recognition and decoding skills, this definition puts fluent reading as central in the assessment of reading problems.

Early Reading Issues

Word Reading Fluency and Reading Fluency Skill

The concept of reading fluency has become the focus of much reading intervention research over the last several decades, and definitions of fluency have varied even within the research literature. In virtually all definitions, there is some mention of quick and accurate reading. However, some researchers have provided definitions of reading fluency that go well beyond references to rate and include grouping words into meaningful phrases as one is reading (cf. Aulls, 1978) and prosodic reading (reading with expression) (Allington, 1983). Hudson, Mercer, and Lane (2000) concluded that the richest interpretation of this concept would be to describe it as accurate reading at a minimal rate that includes appropriate prosodic features/expression and deep understanding.

Almost all definitions of fluency describe it as the outcome of learned skills (Wolf & Katzir-Cohen, 2001). Similarly, as Schwanenflugel (in press) described, most researchers would concur that reading fluency is not a single skill but rather an accumulation of several subskills. Wolf and Katzir-Cohen (2001) also noted that the relation of these subskills to "fluency" is not clearly delineated. These component skills include – but may not be limited to – automaticity, word recognition, and comprehension.

Why Early Reading Skill is Important to General Academic Achievement

The most common type of reading problem for those later described as "reading disabled" is the inability to accurately and fluently identify printed words (Ehri & Wilce, 1983; Gelzheiser & Clark, 1991; Torgesen & Wagner, 1998). Although issues of comprehension and breadth of vocabulary become increasingly salient as children move through school, researchers generally agree that the inability to decode words is a primary cause of comprehension problems in elementary-aged children as well as in older children who continue to struggle with decoding (Stanovich, 1991). Thus, early identification of word reading difficulties is of paramount importance in assisting children in the reading development.

Beyond the primary school years, instruction in word recognition and spelling declines considerably, and the emphases turn to comprehension and related strategies (Leach, Scarborough, & Rescorla, 2003). Written materials in nearly all academic areas become increasingly demanding vis-à-vis length, vocabulary level, syntactic complexity, and conceptual demands. Moreover, text comprehension becomes the focus of most assessments, and children who have not mastered the fundamental skills of reading fall behind. As Spear-Swerling (2006) noted, as they advance in school, children who are poor readers (i.e., those who are not fluent) have difficulty keeping up with the high volume of reading required for academic success beyond the elementary school years. It becomes clear that early identification of word reading difficulties is of paramount importance to assisting children in reading development.

It has been demonstrated that it is extremely difficult to make up for the large amounts of reading practice that are missed by children with dyslexia if appropriate instruction is put off until after they have already failed in reading for their first few years of school (Schatschneider & Torgesen, 2004). Several studies have also demonstrated that the poor first-grade reader almost invariably continues to be a poor reader (Francis, Shaywitz, Stuebling, Shaywitz, & Fletcher, 1996; Torgesen & Burgess, 1988). Although remedial strategies such as tutoring can help children improve their reading skills, students who lack the requisite skills to engage in assigned reading tasks are less likely to receive reinforcement for their unsuccessful efforts and are more likely to seek reinforcement from other behaviors, such as attention from peers (Gest & Gest, 2005).

While some studies of remedial efforts with older children have shown that it is possible to close the gap in phonemic decoding ability, word reading accuracy, and reading comprehension if those children are provided with interventions that are appropriate and sufficiently intensive (Allington & McGill-Franzen, 1994), the fluency gap remains relatively unaffected by even such powerful interventions (Torgesen, 2004).

As Torgesen (1998) noted, greater intensity and duration of instruction is required because the increased explicitness of instruction for children who are at risk for reading failure necessitates that more things be taught directly by the teacher. Intensity of instruction is increased mainly by decreasing teacher/student ratios. Unless beginning reading instruction for children with phonemic weaknesses is more intensive (or lasts significantly longer) than normal instruction, these children will significantly lag behind their peers in reading growth.

Phonemic Awareness and the Development of Phonemic Decoding Skill

Evidence suggests that good predictors of future reading success (or lack thereof) and dyslexia are the rapid naming of objects, colors, letters, and words and phonemic awareness at the preschool level (Spafford & Grosser, 2005). The first three are usually mastered in the earliest years. Liberman et al. (1989), in addressing the question “What is required of a child in learning to read a language but not in speaking or listening to it?” posited that the child must master the alphabetic principle. Specifically, this entails an awareness of the internal phonemic structure of words of the language. This awareness must be more explicit than is ever demanded in the ordinary course of listening and responding to speech. If this is so, it should follow that beginning learners with a weakness in phonemic awareness would be at risk.

Phonemic awareness is the ability to focus consciously on the individual sounds that make up words (Beals, DeTemple, & Dickinson, 1994). Others have described it as the ability to isolate the different sound components in a word and then to analyze and interpret these sounds (e.g., look = /l/u/k/) (Liberman, Rubin, Duques, & Carlisle, 1985). Phonemic awareness has consistently been the best predictor of the acquisition of accurate and fluent word reading skills (Wagner, Torgesen, Laughon, et al., 1993). Moreover, evidence from both experimental and longitudinal studies performed in several countries suggests that some form of phonemic awareness is necessary to successfully learn to read all alphabetic languages (Blachman & James, 1985; Bradley & Bryant, 1983; Elkonin, 1963, 1973; Juel at al., 1986). Thus, phonemic awareness appears to be a core component skill of alphabetic literacy, which is equally important for learners of consistent and inconsistent orthographies (Caravalos, Volín, & Hulme, 2005).

Phonemic awareness instruction leads to improvement in students' phonemic decoding, reading, and spelling (NRP, 2000). Deficits in phonemic awareness have been associated with later reading disabilities (Lyon, Shaywitz, & Shaywitz, 2003), and the assessment of phonemic awareness in preschool and early kindergarten provides useful information as to the skills children use to read (Adams, 1990). Lonigan, Burgess, and Anthony (2000) found that, in comparison to many other predictors, phonemic awareness was the most robust and stable indicator of later reading in a group of children followed from preschool to first grade.

Additionally, Catts, Fey, Zhang, and Tomblin (2001) reported that a kindergarten measure of phonemic awareness was one of five factors that predicted later reading disability diagnoses in second grade, and Juel (1988), in a study of 54 children from first through fourth grade, found that the children who became poor readers entered first grade with little phonemic awareness. Numerous other studies have documented this relationship (e.g., Calfee, Lindamood,

& Lindamood, 1973; Lonigan et al., 2000; Torgesen, Wagner, & Rashotte, 1997; Wagner et al., 1997).

Torgesen (1999) elaborated on the discussion of phonemic awareness by explaining how readers must be able to ultimately blend together the individual phonemes that are identified in a given word, as this method is the most reliable way to identify words that are not recognized by sight. Stanovich et al. (1984a) depicted a path model of the relationships among the various components of fluency, and they found that there was considerable support for a general, broad reading phonemic "factor." For example, they cited one finding showing that a 7-minute (15-item) phonemic awareness test correlated with reading ability more robustly than a comprehensive hour-long intelligence test.

However, once children actually begin learning to read, the best diagnostic indicators of dyslexia are measures of phonemic decoding efficiency (i.e., those that assess both accuracy and speed of phonemic decoding abilities; Raskind et al., 2005) and word reading fluency, *not* measures of phonemic awareness or rapid automatic naming (RAN) (Torgesesn, Otaiaba, & Grek, 2004). Evidence for this has been seen consistently in the research. For example, in a study conducted by Frost (2001), 44 children were divided into two groups: one group with a high entrance level of phonemic awareness into grade 1 and a second group with a low entrance level of phonemic awareness. These two groups were followed and tested with the same battery of tests at six occasions from the beginning of grade 1 until the middle of grade 2. One significant result was that the "impact of phonemic awareness on reading development seemed to be catalytic" (p. 81). As soon as actual reading ability developed, the solitary effect of phonemic awareness on reading disappeared. Thus, phonemic awareness was considered to be of crucial importance at the very start of reading development, but as soon as fundamental phonemic decoding strategies develop, phonemic awareness seems to be integrated into broader and more comprehensive linguistic strategies. Moreover, despite the significance of phonemic awareness in the earliest school years, it has been suggested that once children learn to read, the best indicator of current and future reading skills may be reading itself (Bell, McCallum, & Cox, 2003). Once information is obtained about children's actual progress in learning to read words accurately and fluently, the more distal measures of phonemic awareness and RAN add little to the diagnostic accuracy of identifying children with dyslexia (Schatschneider & Torgesen, 2004).

Why Phonemic Decoding is a Key Indicator of Reading Skill

Phonemic decoding is defined as the recognition of sound/symbol correspondences as meaningful units for use in speech, listening, writing, and reading and requires mastery of the relationship between approximately 40 phonemes (the smallest units of sound in a language) in the English language to letters and multi-letter units (sometimes called *graphemes*). Coltheart (2005) noted that children who learn the rules relating letters to sounds are at an advantage when learning to read because there are very few words that children will be able to recognize by sight but many words that they can recognize when sounded out. This is why assessing a child's ability to read nonwords is a crucial component of any effective measure of reading. The only way to gauge how well a child can employ letter-sound rules to translate print to speech is by having them read aloud pronounceable nonwords (e.g., *soid*). Children who are allowed to persist with significant phonemic decoding problems for too long miss out on a great deal of reading practice that is crucial in the growth of reading fluency (Torgesen, Rashotte, & Alexander, 2001), vocabulary (Cunningham & Stanovich, 1991), and reading comprehension skills (Snow, Burns, & Griffin, 1998).

Research has supported the view that phonemic decoding skills maintain their importance to developing reading skill by demonstrating its stability in being diagnostic of reading difficulties over time. In one study by Svensson and Jacobson (2006), participants were 40 second grade children with documented reading and writing difficulties with a comparison group of 30 students without documented reading and writing problems. The participants were followed over a 10-year period by word- and nonword-reading tests as well as tests of cognitive ability. The persistence of phonemic deficits was reflected in the high correlation between nonword-reading test scores in grades 3 and 12 in the reading-disabled group. A dyslexia cut-off definition based on phonemic ability was the most consistent definition over time compared to a word-decoding definition or a multiple cut-off definition based on IQ. Phonemic decoding abilities were remarkably stable over time, and nonword-reading was found to be a valid indicator in diagnosing and discerning dyslexia both in children and adults.

Phonemic decoding is closely related to earlier skills in phonemic awareness because, to map sound onto letters, children must have a solid understanding of the sound system of language first. Research by Tunmer and Nesdale (1985) demonstrated that in first grade, phonemic awareness influences reading comprehension indirectly through phonemic decoding (as assessed by nonword naming tasks). Juel et al. (1986) found similar results. Moreover, they noted that phonemic awareness accounted for 49% of the variance (after accounting for the influence of IQ and listening comprehension) in predicting word recognition at the end of first grade.

Why Word Reading is a Key Indicator of Reading Skill

Reading words by sight is viewed as a different process than is that involving decoding, for many words cannot be read that way because they contain letters that deviate from the conventional spelling system. Despite this, most people are able to read these irregular words easily because they have stored them as sight words in memory. However, the process of sight word reading in not limited to those irregular words, as all words that are practiced enough can become sight words (Ehri, 1996). Although there are other ways in which people read words – not only through phonemic decoding but also through analogy and context clues – those processes require conscious attention, regardless of degree. If a reader tries to decode words, or to find analogous words in memory, or to predict words from context, his attention is shifted at least momentarily from the text itself in order to resolve the word's identity. This suggests that being able to read words automatically (by sight) is the most efficient, unobtrusive way to read words in text (Perfetti, 1985; Stanovich, 1980). Hence, building a sight vocabulary is crucial for achieving general reading skills.

Difficulties in word reading have been identified as the proximal impediment to reading in dyslexic children (Adams & Bruck, 1993). Others have asserted that the most fundamental reading bottleneck for children with dyslexia lies at the word, rather than the text, level of processing (Lyon, 1995; Torgesen et al., 2001). Further, empirical evidence has indicated that deficits in word recognition skills are not only a salient characteristic of dyslexic readers (Compton & Carlisle, 1994; Lovett et al., 1994; Perfetti, 1985) but ultimately have negative consequences for reading comprehension (Adams, 1990).

Torgesen (1999) has furthered this discussion by noting that one prominent characteristic of poor readers is a very limited repertoire of sight words that can be read fluently and automatically, adding that weaknesses in word reading accuracy and fluency are particularly diagnostic of reading problems at all age levels. It is this difficulty in rapid word recognition that limits comprehension in older poor readers, for these skills afford children the opportunity to focus on constructing the meaning of what they are reading rather than spending too many of their cognitive resources on trying to identify the words (Adams, 1990).

Torgesen et al. (2001) stated that two obvious and related consequences of failure to acquire the early requisite reading skills at a normal rate are relative limitations in overall time spent reading and, more specifically, in the amount of practice reading individual words. As such, they argued that this “sight word vocabulary” is key in closing the gap between the words read by average or good readers – estimated by Nagy and Anderson (1984) as 1 million words per year – and those read by poorer readers, estimated at 100,000 words per year (Wolf & Katzir-Cohen, 2001).

A significant amount of exposure to text through extensive reading practice is essential to growth in the number of words children can recognize orthographically (i.e., by the familiar patterns of letters), and the best explanations of the way children acquire these representations (cf. Ehri, 1998; Share & Stanovich, 1995) require that individual words be identified accurately on several different occasions during the text reading. If words are not identified accurately in sufficient numbers or repetitions, then accurate orthographic representations are not formed, and words must be recognized through analytic means (e.g., phonemic analysis, context, analogy) that take more time than does recognition. Hence, this provides more evidence for the assertion that one of the primary characteristics of most dyslexic children after the initial phase of learning to read is a severe limitation in the number of words that can be recognized instantly (Rashotte et al., 2001; Torgesen et al., 2001; Wise, Ring, & Olson, 1999).

Torgesen et al. (2001) furthered this discussion by describing how inefficiency in identifying single words is the most important factor in accounting for the individual differences in text reading fluency in dyslexic children. They also found that reading fluency problems of those children were especially pronounced for passages that were closer to their grade level expectancy and which contained many words they could not easily identify. When these results are viewed in light of the fact that the number of less frequent words (those children are less likely to have encountered before in text reading) increases rapidly after about third grade (Adams, 1990), it is apparent why it is so difficult for children who have failed in reading for the first few years of school to close the gap with their normally achieving peers in reading fluency.

Furthermore, if successively higher grade level passages include increasing numbers of less frequent words, and if normal readers are continually expanding their sight vocabularies through their own reading behavior, it will be very difficult for children already behind in their sight-word vocabulary to catch up. Even if word reading accuracy is substantially increased through the more efficient use of analytic word reading processes (Torgesen et al., 2001), reliance on such analytic processes will not produce the kind of fluent reading that is supported by the aforementioned orthographic word recognition processes.

The Relationship Between Word Reading and Phonemic Decoding: Models

Most researchers have identified certain phases that children go through when learning to read. Many current reading theories link phonemic decoding and word reading skills by demonstrating how good decoding skills are crucial in the development of accurate memory for the spelling patterns that are the foundation for sight word reading (Ehri, 1998; Share & Stanovich, 1995). Spafford and Grosser (2005) noted an important milestone in the development of word recognition abilities is reached "when students can successfully decode or use phonetic cues" (p. 103). Others have stated that decoding is the foundation of sight word reading and has been found to be the single best predictor of reading comprehension (Tiu et al., 2003). Stanovich, Cunningham, and Freeman (1984_a) described a causal model in which, fundamentally, phonemic awareness facilitates decoding skill, which in turn determines word recognition ability, which (in conjunction with listening comprehension), facilitates reading comprehension.

Marshall and Newcombe (1973) and Forster and Chambers (1973) both described a "dual-route" model of reading. Coltheart (2005) expanded on this by invoking the term "dual-route cascaded model", or DRC, as it explains the process of moving from print to speech (i.e., when reading aloud). This model includes "a direct lexical reading route that maps between lexical orthography and lexical phonology without requiring access to word meaning" (Blazely, Coltheart, & Casey, 2005). The dual-route model proposes that two types of mechanisms, which are in part neuroanatomically distinct, support reading aloud (see. Coltheart, Rastle, Perry, Ziegler, & Langdon, 2001). One pathway, the lexical route, is implicated in the retrieval of stored information about the orthography, semantics, and phonology of familiar words. An alternate pathway, the nonlexical route, allows readers to derive the sounds of written words by use of mechanisms that convert letters or letter clusters into their corresponding sounds. The nonlexical route is functionally limited in that it does not provide information about a word's meaning; nor, in a language like English or Italian, does it guarantee the correct pronunciation of certain number of words. Nevertheless, the nonlexical route is responsible for deriving the sounds of nonwords; damage to this pathway or mechanism would result in phonological dyslexia (Berndt, Haendiges, Mitchum, & Wayland, 1996; Coltheart, 1985). The term phonological dyslexia is used by neuropsychologists to describe reading deficits that affect nonwords (nep, cabe) more severely than familiar words (Caccappolo-van Vliet, Miozzo, & Stern, 2004).

Because of the interrelated nature of the skills comprising the DRC model, if a child is behind in acquiring any one of them, then the child's reading will be abnormal in some way.

Perhaps most noteworthy in this depiction is the way visual word recognition and letter-sound rule application comprise the second step after basic letter recognition. This model is useful not only for understanding children's fundamental reading difficulties but also for assessing them. This may be seen as contributing evidence to the hypothesis that tests that specifically measure a person's phonemic decoding and those that measure single word reading are useful tools.

It has been stated that comprehension of text is considered the goal of all reading (Neuhaus et al., 2006). Several models have been espoused to adequately represent reading comprehension, and perhaps one of the most elegant is the *simple view* model defined by Gough and Tumner (1986) that cites decoding and listening comprehension as two necessary subskills of reading comprehension. The fundamental tenet in this model is defined by its "multiplicative framework" vis-à-vis the two subskills; i.e., the absence (numerically: zero) of either decoding or listening comprehension skill would result in the absence of reading comprehension skills, as anything multiplied by zero would be zero. However, as Juel (1988) noted, word recognition has been shown to be more predictive of reading comprehension than has listening comprehension, although the latter's impact tends to increase at each elementary grade level.

Moreover, according to Byrne and Gates (1992), reading comprehension can be predicted completely by two measures; nonword decoding accuracy and nonword decoding speed. The researchers followed 159 children in grades 2 and 3 over one year and found that accuracy was more important than speed, because slow but accurate decoders could still comprehend what they read while rapid, inaccurate decoders could not. McGuiness (1997) has posited that this provides evidence that fluency follows accuracy and does not precede it.

More recently, Savage (2006) explored the assumptions underlying the "simple view of reading," i.e., reading comprehension = decoding × linguistic comprehension (Gough & Tunmer, 1986). To evaluate this model, Savage analyzed the performance of 15-year-olds with severe reading delays. Results showed that decoding and linguistic comprehension described reading comprehension better than decoding and verbal cognitive ability *as long as nonword reading was used to measure decoding* (emphasis added). If text-reading accuracy was used to index decoding, then verbal ability, not linguistic comprehension, provided the best fit. An additive model (decoding + linguistic comprehension) fitted the data well when either nonword decoding or text-reading accuracy was used as an index of decoding. The addition of the multiplicative term (decoding x linguistic comprehension) did not add to the predictive power of the model. This appears to provide more evidence that assessment of nonword reading (decoding) skill is a vital component of any measure purporting to yield some predictive value vis-à-vis reading comprehension.

Ehri's (1992, 1997) theory of automatic sight-word reading provides specificity in understanding the development of word reading speed. She asserted that automatic (fluent) word reading is dependent on a complete analysis of a word accomplished by forming "connections between graphemes seen in the spellings of specific words and phonemes detected in their pronunciations" (1997; pp. 169–170). Ehri and Wilce (1983) found that less skilled readers do not form these complete connections. Similarly, Swanson (1998) asserted that many poor readers have difficulties because they fail to establish effective, efficient visual-verbal connections, which consequently may lead to problems in accessing or laying down long-term memory traces.

LaBerge and Samuels (1974) described an automaticity theory of reading that focuses on proficient word recognition and decoding skills as the foundations of fluent reading and adequate comprehension. Calfee and Piontkowski (1981) stated that efficient word recognition leads to better comprehension, not vice versa. Later, Stanovich, Freeman, and Cunningham (1984) suggested that a continuous word list procedure was a highly effective predictor of reading ability in general. However, as Meyer and Felton (1999) noted, whether or not the direction between fluency and comprehension is reciprocal remains to be resolved, particularly when considering that fluency must include in its definition accuracy, rate, and prosody (Stahl, 2004).

It was later hypothesized that phonemic awareness contributes indirectly to reading comprehension skill through its direct effects on word recognition (Stanovich, 2000). This has contributed to the much cited “phonemic core deficit” explanation of reading disability. The phonemic-core model proposes that *virtually* all aspects of reading require phonemic processing, and that at the core of dyslexia is a single deficit in phonemic processing. Conversely, the double-deficit hypothesis proposes that orthographic and phonemic processes function independently of each other, and that each, if impaired, can give rise to dyslexia. Some researchers have begun to investigate the neurophysiological basis of this deficit (Hynd, et al., 1999).

Considering reading from the simple view (Gough & Tunmer, 1986) as the product of decoding words and comprehension, it seems difficult to separate phonemic and semantic prerequisites in word reading ability. Frost et al. (2005) assert that in order to define the etiology of reading ability and to plan for early prevention of later reading and spelling difficulties, phonemic processing and semantic processing on many levels should be considered as interacting processes.

In terms of word reading itself, for some time, researchers suggested that word reading involved at least two potentially independent processes: a “direct” process for recognizing irregular words (e.g., “yacht”) and an “indirect” process involving the use of phonemic decoding skills for sounding out unfamiliar words or nonsense words (“pseudowords”) (Coltheart, 1978).

However, more recently investigators have argued that the demarcation between these two processes may be less distinct (Van Orden, 1987; Van Orden, Pennington, & Stone, 1990). For instance, Van Orden (1987) has reported that irregularly spelled words are not completely phonologically obscure. For example, although the cited example *yacht* is irregular, the *y* and *t* do receive regular (i.e., predictable) pronunciations. Therefore, phonemic processes may play a role even in the recognition of irregular words (Rack et al., 1992).

Research has indicated that there are at least 3 ways in which phonemic awareness – which underlies phonemic decoding skill – facilitates the growth of accurate and fluent word reading skill:

1) It helps children understand the alphabetic principle (learning to “sound out” words)
2) It fosters the generation of possible words in context that are only partially sounded out
3) It helps children notice the regular ways in which letters represent sounds in words; e.g., by “hearing” four sounds in the word “clap,” they can begin to notice the ways in which letters correspond to the sounds (Ehri, 2002; 1998).

Moreover, evidence for the importance of phonemic awareness, and subsequently phonemic decoding skills, in word reading development comes from a number of studies that look at the relationship between the first process and later reading achievement. In a large number of studies, the correlation between sound segmentation skills (use of the alphabet principle) and reading achievement scores has been shown to be highly significant (Bradley & Bryant, 1983; Calfee, Lindamood, & Lindamood, 1973; Tunmer, Herriman, & Nesdale, 1988).

Similar findings were noted in research by Juel, Griffeth, and Gough (1986). They followed 129 children from early first grade through second grade and measured the children’s phonemic awareness, decoding skill, listening comprehension, IQ, and various measures of writing and spelling. Reading comprehension over the two years was predicted by reading and spelling isolated words, and these in turn were predicted by decoding accuracy, which in turn was predicted by phonemic awareness.

Season of Birth Issues

Despite the relative paucity of empirical research, persons working in the field of education have long known that children who are the youngest in their class (and are typically born in the summer) are at a disadvantage compared to their older grade cohorts (Gledhill, Ford, & Goodman, 2002). This phenomenon has a number of permutations relevant to the educational realm and has been associated with overall academic achievement (Alton & Massey, 1998), math achievement (Borg & Falzon, 1995; Crosser, 1991), personality traits (Chotai, Lundberg, & Adolfsson, 2003), referral to remedial services (Gledhill, Ford, & Goodman, 2002), emotional-behavioral adjustment (Kinard & Reinherz, 1986), referral to psychological service (Menet, Eakin, Stuart, & Rafferty, 2000), and emergent literacy skills (Crone & Whitehurst, 1999). Studies have shown that, more often than not, children born in the summer months experience more untoward sequelae in a number of emotional, behavioral, and academic domains.

There is also a literature indicating that season of birth is related to rates of learning disability diagnoses. In a typical study, Erion (1986/87) studied 67 children with specific learning disabilities (SLD) in first through sixth grades and 67 matched controls, and summer born children were found to have higher rates of SLD. Similar results have been obtained by Badian (1984), Bookbinder (1967), Diamond (1983), Livingston, Balkozar, and Bracha, (1993), and Wallingford and Prout (2000). Most school districts have established a fall cut-off date for school entrance (e.g., September 1); children whose birthdates fall in the months just prior to the cut-off date, therefore, are the youngest in their grade. Thus, the preceding findings have most often been attributed to maturity as reflected by relative age in a given school grade. More specifically, many researchers have considered this *maturational hypothesis* to encompass the fact that those children who are youngest in their grade are less neurologically mature than their older peers.

However, as Gredler (1980) asserted, although “All western societies talk of a birthdate effect” (p. 11), there have been inconsistencies and confounds among the small number of existing studies. Gredler made a case for the potential misuse of any data purported to show “season of birth” effects on children’s academic achievement. He chided other researchers who had suggested that because data indicated younger children tend to be referred for special education more frequently than the older peers in their grade, this is proof that such children are experiencing maturational difficulties. Gredler went on to assert that one must not simply investigate the child’s maturational scheme but also ask if “the maturation of the teachers and school psychologists who work with these children is developing more slowly (p. 10)?” The author’s stand was to draw attention to the potential influence of teachers’ and school personnel’s beliefs and expectations about a young child’s (particularly young males’) likelihood of experiencing schooling difficulties, and reading difficulties in particular.

Still, a sizeable body of research indicates that summer-born children are at an achievement disadvantage. For example, Thompson (1971) studied 1,136 boys at a private school in England. By the fourth year of school, autumn-born children (the oldest in their grade) tended to be in the top "stream" while summer born children (the youngest in their grade) tended to be in the bottom stream. Other studies finding a significant relationship between relatively poor academic achievement and age include those of Bergund (1967), Davis, Trimble, and Vincent (1980), DeMeis and Stearns (1992), Jinks, (1964), France and Wiseman (1966), and Pumfrey (1975). Although there have been many research efforts aimed at identifying contributing and causal factors in children's academic achievement (cf. Hart & Risley, 1995; Breslau, Johnson, & Lucia, 2001; McGuinness, 1997), many of the studies have been replete with confounds. These include both acknowledged and unrecognized genetic, environmental, socioeconomic, familial, and instructional variables.

Recently, Martin et al. (2004) analyzed educational and birth pattern data from a large cohort of Georgia public school children. They found that, consistent with the hypothesis, Georgia children born in late summer are overrepresented in the population of children diagnosed with any category of learning disability. Further, evidence suggests that children born in this period are more likely to have more academic problems in general (based on standardized achievement scores) than children born in other times of the year. Martin et al. (2004) have provided other possible explanations for the summer-born children's higher risk of academic difficulties, including one, which they deemed *the self-concept hypothesis.* It posits that the youngest children in a grade cohort may be at a social disadvantage to others in their given grade with regard to physical stature, strength and abilities, social skills, and perhaps aspects of cognitive maturity (Menet et al. 2000).

The maturational and self-concept hypotheses were afforded some support by Diamond (1983), who studied children with an SLD diagnosis in the State of Hawaii. During that period (school year 1979-1980) the cut-off date for school entry was January 1. Month of birth was numbered from 1 to 12, beginning in January. The resulting correlation between month of birth and proportion of all students who had been given an SLD diagnosis that were born each month was .86 for girls and .94 for boys. Approximately 50% more children required special services if they were born in December (youngest in grade) rather than January (oldest in grade). The results of the Diamond study are important primarily because they demonstrate that even with a

January 1 cut-off date for school entry, there was a strong relationship between number of SLD diagnoses and age in grade, with youngest students receiving more SLD diagnoses.

The SLD and achievement literatures as related to season of birth indicate that children born in the summer have an increased probability of lower achievement levels, school failure, referral for psychological evaluations, and of being diagnosed as having SLD (Martin, et al.,). However, the literature that relates season of birth to these outcomes is small and suffers from several methodological shortcomings that limit its impact. For example, of the less than 20 studies that have been published on season-of-birth and SLD, many researchers have had small sample sizes (e.g., Erion, 1986/87), have not included females (e.g., Badian, 1984), or have failed to control for normal birth patterns in the population (e.g., Livingston, Balkozar, & Bracha, 1993). Further, in no study was it demonstrated that a lower general achievement in a given school population had a similar season-of-birth pattern as the rate of learning disability diagnoses in that school population. Additionally, as will be shown below, the results are somewhat contradictory.

What the Research on Reading Shows

Crone and Whitehurst (1999) investigated the relationships among age, amount of schooling, emergent literacy, and early reading skills in a sample of children in a Head Start program. They found that the oldest children (summer born) in preschool and kindergarten had significantly stronger emergent literacy skills than did their classmates who were 10 months younger. However, these differences did not translate into differences in reading skill at the end of first or second grade. Additionally, the authors found that children who began school a year earlier than their same-age peers outperformed those children on tests of both emergent literacy and early reading skills. Their results suggest that, despite early lags, younger children in this sample caught up to their older peers on measures of reading achievement. They also noted that the extra year of schooling for some of the children was a stronger predictor of reading skills than was age.

In a related investigation, Davis et al. (1980) compared groups of children who had started school either at age 5 or 6 on first grade, fourth grade, and eighth grade achievement tests. In this case, there was no difference in the length of schooling among children in the same grade. The authors found that in both the first and fourth grade samples, children who started school at age 6 outperformed the 5-year-old entrants on measures of reading, math, and language. Additionally, Davis et al. noted that, in the eighth grade sample, the observed differences in scores appeared to decrease *with the exception of the reading scores.*

There have been other investigations in this domain that show different results. Crosser (1991) compared academic achievement scores taken at fifth or sixth grade for summer birth date children who entered kindergarten at age 5 with summer birth date children who started kindergarten at age 6. Scores on standardized achievement measures were analyzed for 45 pairs of children who were matched for ability and gender. Results showed statistically significant differences favoring the summer-born children who entered school at age 6; moreover, Crosser found a particular advantage in reading at fifth or sixth grade for those summer born children who postponed kindergarten until age 6.

Similar studies have looked at season of birth and special education qualification. In a study of British schoolchildren ages 5-15, Gledhill et al. (2002) found that the proportion of children qualifying for special education was significantly higher among summer-born children than among autumn-born or spring-born children. However, they found no significant differences in IQ, reading ability, spelling ability, or specific learning disabilities between children born in each season. Interestingly, the authors found that, despite the relative concordance among their scores, the younger children were more likely to be described by their teachers as having learning difficulties than were their older classmates, which harkens back to Gredler's admonition.

Other investigators have tried to account for effects of gender and cognitive ability in season of birth and reading achievement. For example, Bibby et al. (1996) looked at the effects of season of birth and gender on academic achievement and cognitive abilities among children attending schools serving learning-disabled students. The authors found that both boys and summer-born children performed better on tests of intelligence, mathematical ability, and reading comprehension than did their peers. Summer born children also performed better on a measure of communication skills. Further analyses showed that for both gender and season of birth, IQ was the major predictor variable, followed by reading comprehension, math ability, and communication skills. For gender, IQ discriminated better than any other variable, whereas with season of birth the relative sizes of the effects were more comparable. However, Bibby et al.'s sample size (N= 87) and disproportionate number of boys suggests methodological shortcomings.

Still others have found results that add further complexity to the discussion. For example, Menet et al. (2000) found a significant main effect between month of birth and performance on literacy measures, with the youngest children in their classes performing more poorly than their older classmates. However, the authors described how, in this study, the "youngest children" (living in Northern Ireland) were those born in May-June, not July-August, as has thus far been assumed.

Flynn, Rahbar, and Bernstein (1996) studied the relationship between season of birth and reading outcomes between two groups of second graders. The authors looked at the joint associations of gender, age at school entrance, season of birth, and reading outcome. They found a significant interaction between reading failure and age category (overage at school entrance vs. correct age) by season of birth; however, Flynn et al. hypothesized that this was probably caused by kindergarten entrance cutoff birth dates. Additionally, although 67.8% of all overage children had summer births, only 15.3% failed in reading, which was not statistically different from the percentage of summer born, correct age low readers. The authors suggested that reported associations may be due to selective sampling. However, the phrase “not statistically significant” may not capture the real-world effects of the differences.

Badian (1981) investigated season of birth effects and reading achievement in a sample of 814 children in grades 1 to 6 and found significant differences in both reading achievement and the prevalence of reading disability; however, this result was seen for boys and not girls. Badian (1984) also found a negative correlation between reading scores and mean birth month temperature for summer-born children, and she suggested that one explanation may be that hot summer temperatures are the final insult to the newborn who may already be at risk for reading problems due to some teratogen earlier in the pregnancy.

Potential Validity Issues in Season of Birth Research

As the aforementioned discussion has addressed, researchers and educators have for several years known of evidence that summer born children perform less well academically relative to their spring born peers. However, as research with prematurity issues has shown, season of birth as an explanatory variable has its own potential confounds. For example, as mentioned earlier, the simple observation that summer born children are typically the youngest in their class suggests that achievement differences may have more to do with maturity and developmental issues rather than season of birth. Bergund (1967) looked at data from Sweden, where autumn born children are the youngest in their grade, and found that this group tends to perform worse academically than their peers. An alternative explanation for these differences is differential teacher expectations of younger children and the reciprocal nature of immature behaviors and interactions with teachers. Further, evidence suggests that use of different standardized norms in looking at reading achievement (e.g., age vs. grade) can yield different results (Gledhill, Ford, & Goodman, 2002).

In addition to the maturational and self-concept hypotheses, there exist several others which have served as potential explanatory factors in the summer-born/lower academic achievement phenomenon. These attribute cognitive and/or emotional disorders to environmental factors operating during the time of conception, pregnancy, and/or birth. These putative environmental influences may themselves be subject to ecological seasonal variations such as temperature fluctuations or allergen levels. For example, Elter et al. (2004) reported that exposure to low outdoor temperature during midtrimester was associated with low birth weight. Such environmental influences may also be functions of recurrent changes in the characteristics of a certain geographic region (e.g., levels of radiation or toxins released in the air, incidence of influenza). Still others may reflect static geographical factors (e.g., latitude; see Davies et al., 2003).

In this respect, any season of birth pattern observed in the prevalence of the disorder in question is ascribed to some environmental exposure(s) or perturbation(s) that occurred at a critical point during neurological development and, therefore, contributed to increased risk of some disorder. The insult(s) could occur prenatally, perinatally, or postnatally – times associated with the well-known plasticity of the central nervous system during early development (Hauschild, Mouridsen, & Nielsen, 2005; Castrogiovanni et al., 1998).

This basic premise is not new, as those in the medical field have known for years that certain environmental factors present during fetal development can have deleterious effects on various neurological, physiological, and genetic-related outcomes. More well-known examples include the impact of prenatal exposure to alcohol, cigarettes, cocaine, lead, chemicals (e.g., thalidomide), and illness (e.g., diabetes; see Sesma & Georgieff, 2003), to name but a few.

A number of researchers have investigated the possible role of prenatal environmental perturbations in the risk for developing various forms of psychopathology and psychiatric disorders as well, including schizophrenia (Collip, Myin-Germeys, & Van Os, 2008; Tsuang, 2000), bipolar disorder (Carter, 2007), major depression (Watson et al., 1999); conduct disorder and antisocial behavior (Maughan et al., 2004; Wakschlag & Hans, 2002; D'Onofrio et al., 2008); ADHD (Button et al., 2005; Mick et al., 2002; Rodriguez & Bohlin, 2005), and physically aggressive behavior (Huijbregts et al., 2008).

More recently, researchers have investigated *seasonal* variations in the incidences of particular medical conditions. For example, Hoffman et al. (2007) found that in a sample of children born between 1995 and 2001, the incidence of medulloblastoma (one of the most common types of pediatric brain tumors) was significantly higher for children born in October. Torrey et al., (2000) found evidence suggesting a seasonal birth pattern in epilepsy, with an excess of births in winter and a deficit in September. Other researchers have found that, compared to autumn-born infants, those born in winter or spring tend to be heavier (Selvin & Janerich, 1971; Roberts, 1975; Tustin et al., 2004), and longer (Waldie et al., 2005; McGrath et al., 2005). Several studies have found that these differences persist into adulthood, e.g., at age

18, those born in the winter or spring tend to be taller than summer/autumn born individuals (Weber et al., 1998; Waldie et al., 2000). Others have reported seasonal patterns in conditions as diverse as asthma (Aberg, 1989), glaucoma (potentially related to prenatal ocular development during winter months; Weale, 1993), and breast cancer (Albrecht, 1990).

A particular season of birth effect is one of the most consistently replicated associations in the epidemiology of schizophrenia (McGrath et al., 2006), i.e., that there is a 10% excess of births in the winter and early spring among those diagnosed with schizophrenia (Castrogiovanni et al., 1998). Most research in this field has recognized the possibility that prenatal exposure to some environmental factor/perturbation is one contributing variable in schizophrenia. The growing empirical base in this domain has no doubt contributed to interest in exploring seasonal effects in various psychiatric disorders and forms of psychopathology. Research in this area has included investigations into season of birth effects – or lack thereof – in autism spectrum disorders (e.g., March and August: Kolevzon et al., 2006; Barak et al., 1995), Tourette's Syndrome (e.g., no observable pattern: Atladottír et al., 2007), risk of suicide (e.g., May/June: Salib & Cortnia-Borja, 2006; Riordan et al., 2006), ADHD (e.g., September: Seeger et al., 2004), seasonal affective disorder (e.g., melancholic features: February; atypical features: spring/summer; Pjrek et al., 2004), eating disorders (e.g., May: Rezaul, Persaud, Takei, & Treasure, 1998), major depression (e.g., winter: Castrogiovanni et al., 1998), and bipolar disorder (e.g., winter: Gonzales, 1996; Videbach, 1974).

Research into these prenatal perturbation/season of birth associations has extended to domains related to language, learning, and academic achievement. Hauschild, Mouridsen, and Nielsen (2005) discussed seasonal birth patterns in a group of children with severe language disorders, and Alton and Massey (1998) found associations between birth season and performance on secondary school achievement examinations. More than 20 years ago, Russell and Startup (1986) found that the number of secondary school graduates varied as a function of their month of birth. Interestingly, they also found that among those subjects who remained in school until age 18, the oldest in their year group were at an academic advantage. However, by the time these subjects graduated from college, the youngest in their year group showed the best academic performance.

In delineating such results, most of these researchers have acknowledged the potential (and in some cases, likely) impact of in utero exposure to "down-stream consequences of biometereological variables such as temperature, rainfall, and ultraviolet radiation" (McGrath et al., 2006, p. 97) on these season of birth effects in learning and academic achievement. Indeed, Martin et al. (2004), in their investigation into season of birth effects in prevalence of LD diagnoses, discussed the two prominent prenatal perturbation hypotheses relevant to such studies. The *gestational infection hypothesis* (Martin et al., 2004) reflects the seasonal variations in particular illnesses, e.g., pneumonia and influenza, both of which show peaks between early December and early March (Glezen & Couch, 1997). In utero exposure to such infections is hypothesized as potentially having impact on the fetus' CNS development, and, consequently, on later learning abilities.

The second hypothesis – deemed the *gestational vitamin D hypothesis* – refers to the potential impact of reduced available ultraviolet light during the winter months. This form of light is associated with the body's ability to produce vitamin D, and evidence exists that vitamin D plays a critical role in a fetus' CNS development (Eyles et al., 2003). Regions of higher latitude receive much less ultraviolet light in winter months than do regions of lower latitude, and some research has found an association between prevalence of schizophrenia in areas of high latitude (McGrath, 2001).

With these “prenatal perturbation” factors in mind, it is clear that any season of birth effects found in any domains of learning or academic achievement (e.g., reading skill) must be viewed as potentially secondary to some environmental variable present during a fetus’s development. Regardless, the most obvious implication of such discoveries is that identification of any environmental factor believed to cause some untoward developmental outcome can inform public health policy; this in turn can lead to the implementation of preventive measures that could allow for optimal neurocognitive development regardless of season of birth.

CHAPTER 3

METHOD

Participants

Participants were 1100 1st, 2nd, and 3rd grade students from 11 elementary schools in Georgia and New Jersey. The demographic breakdown of the group is as follows: African American, 32.9%; Caucasian, 40.4%; Hispanic, 20.8%; Asian, 3.2%; and Other, 2.4%. 47% of the subjects were male and 53% were female.

Sixty-six percent of the sample was from the Georgia sites and 34% from the New Jersey sites. The New Jersey site consisted of 7 schools in a working class, suburban location with approximately 40% free/reduced lunch rate across the district. The Georgia schools included 9 urban and rural working class and high poverty schools in 2 counties with free/reduced lunch rates of approximately 77.4% and 44%. None of the schools was participating in the Reading First initiative at the time of the intervention.

All children in general education classrooms participated with the exception of those currently receiving English-as-a-second-language instruction, those in self-contained classrooms for special education, or those who had been retained (as extrapolated by identifying age in grade). Children were not excluded on the basis of reading disability. All children had received parental consent for their participation and they assented to their own participation verbally.

Procedure

This study was part of a larger study on the development of reading fluency and children were given a large battery of standardized tests that measured different aspects of reading skill. My study focused on the Test of Word Reading Efficiency because of the diagnostic nature of word reading skills to assess reading problems, as noted earlier. For half of the children, this assessment was given early in the battery. For the other half, this assessment was given late. Both assessment sites followed this pattern.

Children were tested only once but at various points in the school year. 62.4 % were tested in the fall, 12.4% were tested in the winter, and 25.2% were tested in the spring. 8.9% were tested in first grade, 84.6% were tested in 2^{nd} grade, and 6.5% were tested in third grade. However, I used age-based standards scores in the analyses that correct for the age of the children.

Children were tested at a time convenient for their teachers. Children were asked if they wished to participate and, if they assented, were brought to a quiet location in their school. They were told that they were going to do some reading activities and that they would receive a sticker at the end to thank them for their participation. Children were read the direction for the assessments as described by the respective test manuals. All testing was carried out by testers trained to reach 100% agreement with the lead Ed.S.-level school psychologist during the first three days of testing.

Assessment

The Test of Word Reading Efficiency (TOWRE; Torgesen, Wagner, & Rashotte, 1999) measures a person's ability to read real and nonwords ("pseudowords") fluently (i.e. quickly *and* accurately). More specifically, the TOWRE assesses both the ability to sound out words quickly and accurately (decoding) as well as the ability to recognize familiar words as whole units or sight words. Nonword decoding is analogous to working with unfamiliar real words.

The TOWRE consists of two lists, one comprising moderate to high frequency words and one comprising phonetically regular nonwords.). The individual reads each list aloud and scores are based on the number of words read correctly in 45 seconds. The TOWRE uses two analogous forms ("A" and "B"), and these were used alternately depending on the time of year during which the assessment was given. For purposes of the present research, the delineation of which form was viewed as incidental, as only one set of scores from one testing point for each child was part of the analyses. In fact, alternate-form reliabilities for this test are quite high (.93-.97; Torgeson et al., 1999, p. 63) for children in the age ranges used in this study, so this is reasonable.

The rationale for considering each subtest's scores separately was based on the substantive research base that indicates measures of phonemic awareness and tests of sight word reading are in fact assessing different skills. This is a logical outcome when considering each's theoretical and conceptual underpinnings.

The TOWRE was normed on a sample of 1507 individuals from 30 states which in aggregate represent each of the four major geographic regions of the United States. The subjects were tested in the fall of 1997 and spring of 1998, and the sample was considered representative of the U.S. population based on 1997 census data.

The TOWRE reports test-retest reliabilities between .90 and .97 and validity estimates with other decoding measures of between .91 and .94. The TOWRE provides scales scores for the phonemic decoding efficiency and sight word reading efficacy subtest, and a total reading efficiency composite standard scores which combines the two subtests. The standard score for the total reading efficiency composite has a mean of 100 and a standard deviation of 15.

Planned Data Analysis

The process of data analysis will begin by computation of basic descriptive statistics on the TOWRE-Sight Word and Pseudoword test scores. The raw score means, standard deviations, minimum, maximum, kurtosis, and skewness will be reported. In part this is calculated in order to determine if scores are normally distributed.

Then a frequency distribution by gender and by site for both reading standard scores (Sight Word and Pseudoword) will be created. Using the accepted cutoff standard score (≤ 92; <30th percentile), the students will be grouped in one of two groups: "poor readers" or "adequate readers."

The proportion of students in the poor reader group for each of the four groups as defined above will be compared across gender and site to determine if the data can be collapsed across gender and/or across site. The data will be placed in a 2 x 12 (good reader/poor reader x month of birth) cross-tabulation. The collapsed data sets will be submitted to a chi square test of independence, from which it will be determined if there are significant differences in the proportion of poor readers across birth months.

Additional analyses will be performed that exclude retained students. Retention will be determined by comparing students' birth dates/grades and expected age based on age 5 kindergarten entry. Performing analyses with the exclusion of retained students will be important, as any 1st, 2nd, or 3rd grade student who has been retained has, presumably, had an extra year of reading instruction compared to his same-grade peers.

CHAPTER 4

RESULTS

Table 1 presents descriptive data relative to gender, ethnicity, and grade level for the two samples studied. In both locations the percentages of males and females were comparable. The distribution of ethnicity reflects similar percentages of African American students between the two locations. The Georgia sample reflects a greater percentage of Caucasian students compared to that of New Jersey (approximately 2:1), while the New Jersey sample reflects a greater percentage of Hispanic and Asian students compared to that of Georgia (approximately 3:1 for each). These differences are believed to be functions of geographic issues rather than any systematic differences among the subjects. The relatively higher percentage of students ethnically categorized as “Other” in Georgia may be due in part to a greater overall ethnic diversity in New Jersey compared to Georgia; subsequently, it is possible that evaluators in New Jersey was more practiced in differentiating among various ethnicities.

New Jersey’s sample included no first grade students; this omission was due to the niceties of the particular longitudinal research from which the data were gathered and not to any vital difference among the students in New Jersey. Data from both locations reflect an identical percentage of third-graders.

Table 2 presents the descriptive data relative to statistics for the raw and standard scores of both the TOWRE Sight Word Reading Efficiency and the Phonemic Decoding Efficiency subtests in the two locations (Georgia and New Jersey). In both locations, the average performance in both samples was similar to the expected mean based on the normative data (see Torgesen, 1999). Additionally, the means and standard deviations for both locations were sufficiently similar as to justify combining them in the analyses. Skewness and kurtosis data were within acceptable limits, so test scores were treated as normally distributed.

Torgesen et al. (1999) adopted the working hypothesis that any score falling below the 30^{th} percentile on the TOWRE warrants special interventions to improve word-level reading skills. Specifically, they state that their

> "experience in following the reading growth of children over multiyear periods suggests that phonemic decoding or sight word reading skills below the 30^{th} percentile indicate an increased degree of risk for reading problems that will interfere with a child's ability to make adequate progress in school" (p. 41).

For this reason, it was decided that any score below the 30^{th} percentile would be considered indicative of "poor reader" while any score above that would be considered an indication of an "adequate reader." I used the raw-to-standard-score transformation chart in the TOWRE manual (p. 102, Table C.1) which indicated that a standard score of 92 is equivalent to the 29^{th} percentile and a standard score of 93 is equivalent to the 32^{nd} percentile. Table 3 shows the overall number and percentage of students whose scores on each subtest fell at or below 92 or at or above 93 (included here only to provide an overall scope). There were more students who fell into the "poor reader" category on the PDE subtest relative to the number for the SWRE subtest ($\chi^2 = 6.08$; $p = 0.014$). Because of this difference, I will analyze the PDE subtest separately from the SWRE.

Table 4 shows results according to gender, and it is clear that the number and percentage of students scoring below the 30^{th} percentile on both subtests are quite similar in gender distribution (χ^2 [df = 1] = 0.728; $p = 0.394$). This provided justification for performing an analysis combining both gender groups.

Table 5 shows scores on each subtest according to site. The disproportionate total number of Georgia students relative to New Jersey students (753 vs. 340, respectively) seemed unrelated to the resulting percentages of subjects on both subtests falling in the poor reader category. The distributions were considered sufficiently similar as to justify combining the sites for the primary data analyses (SWRE: $\chi^2 = 3.73$; $p = 0.05$; PDE: $\chi^2 = 2.29$; $p = 0.13$).

Table 6 reflects TOWRE performance according to gender as well as ethnicity. Because of the relatively small number (N=50) of students whose ethnicity was categorized as something other than Caucasian, African-American, or Hispanic, it was decided to investigate potential ethnicity differences using only those 3 demographic groups. As expected, the percentage of students falling below the 30^{th} percentile on each subtest was similar. The main exception to this was seen in comparison of male and female African American students, with boys falling in the "poor reader" category on the SWRE subtest at a higher percentage than girls (relative to gender differences between Caucasian and Hispanic students). However, since this effect was also unrelated to the purpose of this study, it was felt that particular difference did not preclude continued investigation into season of birth effects for the entire sample.

The next analyses addressed the main hypothesis, i.e., that there would be a higher percentage of children born in the summer months who obtained disproportionately lower scores on both TOWRE subtests relative to those obtained by students born in fall, winter, or spring. As expected, the distribution of births per month was relatively even, and no statistical adjustment was necessary. The results in Table 7 show that the months with the two highest percentages of poor readers on both subtests were September and November (both fall). This is in direct contrast to what would be expected based on the working hypothesis.

Because the initial results showed no summer-born/poor reader effects based on birth month, it was not necessary to submit the data to further analyses addressing level of significance for said effects. However, in order to investigate potential seasonal-based differences as well as to increase group numbers, it was decided to collapse months into 6 groups of 2 or 4 groups of 3.

Table 8 shows the performance patterns of subjects classified as poor readers when birth months are combined into 2-month increments. Even though an additional month's worth of data was added to each of September and November (thereby potentially negating the unexpected fall-birth/poor reader effect), the general result was the same. As indicated in Table 9, this result was only amplified when scores were viewed in 3-month groups. Specifically, the majority of the poorest readers – as reflected in scores on both TOWRE subtests – had birthdates in the fall.

Because of potential site-level score pattern differences, the data were further analyzed to address that question. Table 10 shows that Georgia students born in September/October or November/December obtained the lowest scores on both subtests. New Jersey's trend differed slightly in both degree and birth pattern. Specifically, for New Jersey students, the largest percentage of poor readers was seen primarily in November/December. However, this difference in percentage was not significant (SWRE: $\chi^2 = 0.632$; $p = 0.427$; PDE: $\chi^2 = 2.46$; $p = 0.117$), and New Jersey's pattern showed no significant differences in percentage of poor readers in general. Still, these patterns are unexpected based on the summer-born/poor reader hypothesis.

In an effort to account for potential effects of grade and retention differences, a final analysis was performed in which scores in two-month intervals were compared among non-retained students in the same grade. Second grade was chosen, as this reflected the greatest number of subjects ($n = 926$); two-month intervals were used for the same purpose. Table 11 shows the results of these analyses. Consistent with the aforementioned, data suggested that non-retained second graders born in the fall (September/October or November/December) obtained the lowest scores on both subtests.

Table 1

Sample Demographic Variables

Variable	Georgia[a] (*n*=753)		New Jersey[b] (*n*=340)	
	Frequency	Percent	Frequency	Percent
Gender				
Male	344	45.7	169	49.7
Female	409	54.3	171	50.3
Ethnicity				
African American	257	34.1	104	30.6
Caucasian	366	48.6	78	22.9
Hispanic	93	12.4	134	39.4
Asian	14	1.9	21	6.2
Other	23	3.1	2	.6
Grade				
First	96	12.7	n/a	n/a
Second	608	80.7	318	93.5
Third	49	6.5	22	6.5

[a]9 schools.
[b]7 schools.

Table 2

Descriptive Statistics: TOWRE Raw and Standard Scores for SWRE and PDE

Location	Mean	Standard Deviation	Minimum/ Maximum	Skewness/ Kurtosis
Georgia				
Raw SWRE	42.54	16.329	0/86	-.141/-.654
Raw PDE	17.98	11.327	0/56	.610/-.058
Standard Score SWRE	100.93	13.667	57/146	-.194/ .126
Standard Score PDE	99.43	13.356	70/143	.294/-.030
New Jersey				
Raw SWRE	26.20	20.145	1/78	.731/-.738
Raw PDE	18.81	11.734	0/50	.588/-.327
Standard Score SWRE	100.52	12.944	55/129	-.438/.136
Standard Score PDE	99.63	13.431	59/136	.161/-.057

Note. SWE = Sight Word Reading Efficiency; PDE = Phonemic Decoding Efficiency.

Table 3

Percentage of Students in Entire Sample Who Obtained TOWRE SWRE and/or PDE[c]

Standard Scores Below the 30th Percentile

	SWRE (*n* = 285)	PDE (*n* = 337)
Percentage	26.0	31.0

[c] $\chi^2(1) = 0.105$; $p = 0.746$

Table 4

Percentage of Male and Female Students Who Obtained TOWRE SWRE and/or PDE Standard Scores Below the 30th Percentile

	SWRE		PDE	
	Male	Female	Male	Female
Percentage	28.3	24.0	31.3	30.3
Chi-square test	χ^2 (1) = 0.728; p = 0.394		χ^2 (1) = 0.105; p = .746	

Table 5

Percentage[d] of Georgia and New Jersey Students Who Obtained TOWRE SWRE and/or PDE Standard Scores Below the 30th Percentile

	SWRE		PDE	
	Georgia (*n* = 229)	New Jersey (*n* = 84)	Georgia (*n* = 261)	New Jersey (*n* = 102)
Percentage	30.41	24.71	34.66	30.00
Chi-square test	χ^2 (1) = 3.73; p = 0.053		χ^2 (1) = 2.29; p = 0.130	

[d] percent of site total

Table 6

Percentage of Students Who Obtained TOWRE SWRE and/or PDE Standard Scores Below the 30th Percentile According to Gender by Ethnic Group

	SWRE		PDE	
	Male	Female	Male	Female
Caucasian (*n* = 444)				
Percentage	22.79	20.61	24.65	26.75
Chi-square test	χ^2 (1) = .309; p=0.578		χ^2 (1) = .256; p=0.613	
African American (*n* = 361)				
Percentage	36.91	25.47	44.30	36.79
Chi-square test	χ^2 (1) = 5.43; p=0.02		χ^2 (1) = 2.05; p=0.152	
Hispanic (*n* = 227)				
Percentage	29.82	30.09	28.07	27.43
Chi-square test	χ^2 (1) = .188; p=0.965		χ^2 (1) = .115; p=0.915	

Table 7

Percentage[e] of Students Who Obtained TOWRE SWRE and/or PDE Standard Scores Below the 30th Percentile By Month of Birth Compared to Total Sample

	SWRE	PDE
Month (total number births)	Percentage / χ^2 (1)[f]	Percentage / χ^2 (1)[f]
January (*n*=94)	23.4 / 0.322; p = 0.57	36.2 / 1.15; p = 0.284
February (*n*=81)	28.4 / 0.21; p = 0.647	24.7 / 1.34; p = 0.246
March (*n*=90)	28.9 / 0.34; p = 0.56	30.0 / 0.271; p = 0.869
April (*n*=89)	16.9 / 3.69; p = 0.055	19.1 / 5.40; p = 0.02
May (*n*=87)	16.1 / 4.25; p = 0.039	28.7 / 0.167; p 0.683
June (*n*=98)	21.4 / 1.02; p 0.313	31.6 / 0.270; p = 0.87
July (*n*=83)	21.7 / 0.416; p = 0.519	28.9 / 0.133; p = 0.715
August (*n*=99)	29.3 / 0.484; p = 0.486	27.3 / 0.542; p = 0.461
September (*n*=112)	35.7 / 4.79; p = 0.029	39.3 / 3.36; p = 0.067
October (*n*=71)	31.0 / 0.828; p = 0.363	28.2 / 0.222 / p = 0.637

November (*n*=93)	32.3 / 1.68; p = 0.195	40.9 / 3.99; p = 0.046
December (*n*=96)	26.0 / 0.509; p = 0.994	31.3 / 0.721; p = 0.932

[e]percentage of month's total

[f]month compared to total sample

Table 8

Percentage[g] of Students Who Obtained TOWRE SWRE and/or PDE Standard Scores Below the 30th Percentile Based on 2-Month Birth Patterns

Birth Months (2-month total)	SWRE Percentage / χ^2 (1)[h]	PDE Percentage / χ^2 (1)[h]
January/February (*n* = 175)	28.00 / 0.288; p = 0.591	36.00 / 1.87; p = 0.172
March/April (*n* = 180)	27.78 / 0.231; p = 0.631	27.78 / 0.682; p = 0.409
May/June (*n* = 184)	17.39 / 6.36; p = 0.012	29.89 / 0.656; p = 0.798
July/August (*n* = 181)	25.41 / 0.352; p = 0.851	27.62 / 0.756; p = 0.385
September/October (*n* = 183)	38.25 / 11.6; p = 0.001	37.16 / 2.90; p = 0.089
November/December (*n* = 190)	37.74 / 6.11; p = 0.013	40.53 / 6.96; p = 0.008

[g]percentage of each 2-month's total

[h]2-month sample compared to total sample

Table 9

Percentage of Students Born in Each Season Who Obtained TOWRE SWRE and/or PDE Standard Scores Below the 30th Percentile Compared to Total Sample

	SWRE	PDE
	Percentage / χ^2 (1)[i]	Percentage / χ^2 (1)[i]
Season		
Winter (*n* = 271)	25.83 / 0.676; p = 0.934	31.00 / 0.273; p = 0.958
Spring (*n* = 266)	20.68 / 3.32; p = 0.068	25.94 / 2.44; p = 0.118
Summer (*n* = 280)	24.29 / 6.09; p = 0.014	29.29 / 0.252; p = 0.616
Fall (*n* = 276)	33.33 / 5.82; p = 0.016	36.96 / 8.83; p = 0.003

Note. Winter = Σ (December, January, February); Spring = Σ (March, April, May); Summer = Σ (June, July, August); Fall = Σ (September, October, November)

[i] Season's sample compared to total sample

Table 10

Percentage of Students in Each 2-Month Birth Period Who Obtained TOWRE SWRE and/or PDE Standard Scores Below the 30th Percentile Compared to Total Sample According to Site

2-month birth period	SWRE Percentage / χ^2 (1)[j]	PDE Percentage / χ^2 (1)[j]
January/February		
Georgia (*n*=120)	27.50 / 0.114; p = 0.736	35.83 / 1.26; p = 0.262
New Jersey (*n*=55)	29.09 / 0.246; p = 0.620	36.36 / 0.748; p = 0.387
March/April		
Georgia (*n*=124)	27.42 / 0.104; p = 0.747	29.03 / 0.170; p = 0.680
New Jersey (*n*=56)	28.57 / 0.172; p = 0.679	25.00 / 0.854; p = 0.355
May/June		
Georgia (*n*=120)	19.17 / 2.72; p = 0.099	33.33 / 0.316; p = 0.574
New Jersey (*n*=64)	14.06 / 4.60; p = 0.032	23.44 / 1.56; p = 0.211
July/August		
Georgia (*n*=122)	26.23 / 0.136; p = 0.971	28.69 / 0.237; p = 0.626
New Jersey (*n*=59)	23.73 / 0.160; p = 0.689	25.42 / 0.772; p = 0.380
September/October		
Georgia (*n*=139)	43.17 / 17.9; p = 0.000	39.57 / 4.34; p = 0.037
New Jersey (*n*=44)	22.73 / 0.247; p = 0.619	29.55 / 0.329; p = 0.856

November/December		
Georgia (*n*=128)	36.72 / 6.56; p = 0.010	40.63 / 5.06; p = 0.024
New Jersey (*n*=62)	30.65 / 0.632; p = 0.427	40.32 / 2.46; p = 0.117

[j] 2-month's sample compared to total sample

Table 11

Percentage of All Second Graders (Non-Retained) Who Obtained TOWRE SWRE and/or PDE Standard Scores n the 30th Percentile Based On 2-Month Birth Patterns

	SWRE	PDE
	Percentage / χ^2 (1)[k]	Percentage / χ^2 (1)[k]
2-month birth period		
January/February (*n*=121)	24.79 / 0.931; p = 0.760	36.36/ 1.55; p = 0.213
March/April (*n*=130)	18.46 / 3.57; p = 0.059	23.08 / 3.33; p = 0.068
May/June (*n*=144)	15.28 / 7.95; p = 0.005	27.08 / 0.845; p = 0.358
July/August (*n*=125)	16.80 / 5.13; p = 0.024	24.80 / 1.94; p = 0.164
September/October (*n*=133)	32.33 / 2.37; p = 0.124	39.10 / 3.74; p = 0.053
November/December (*n*=143)	31.47 1.88; p = 0.170	39.86 / 4.75; p = 0.029

[k] 2-month's sample compared to total sample

CHAPTER 5

DISCUSSION

The results of the present study did not support the primary hypothesis which proposed that, of all the students with the lowest TOWRE scores ("poor readers") those with summer birthdays would be overrepresented relative to students with birthdays in fall, winter, or spring. In contrast, the results indicated that the greatest percentages of poor readers (based on both SWRE and PDE scores) had fall birthdays (i.e., September-December, inclusive). The results were statistically significant only for September SWRE scores and November PDE scores, although the general fall birthday-poor reader trend was evident during all four months. This phenomenon was magnified when months were collapsed into groups of two and three.

Site comparisons indicated that Georgia's fall birthday/poor reader trend was significant for all four fall months, and while New Jersey's results did not reach statistical significance, the percentage-based trend was similar to that of Georgia's.

Finally, the hypothesis was tested by considering the performance of only non-retained second graders. Consistent with the aforementioned results, the analyses suggested the highest percentage of poor readers (on both subtests) had fall birthdays. For many years, research investigating the effect of month of birth on educational achievement has suggested that performance at school is a function of age; i.e., the youngest in grade are more likely to obtain lower scores on standardized achievement tests in comparison to their older grade-mates. This notion provided some of the impetus underlying the present study's hypothesis. Further, the available research evidence in his area, while relatively scant, has suggested that such age and achievement effects are seen in other more indirect markers of poorer academic performance (e.g., the likelihood of retention or LD diagnoses).

In the American educational system, it is nearly always the case that the children who have summer birthdates (particularly June, July, and August) are the youngest in their grades and are more likely to obtain lower scores on measures of academic achievement. Potential reasons for this have generally been categorized in terms of developmental maturity of older students or season-specific prenatal perturbation(s). However, the results of the present study suggest that, when considering scores on standardized measures of early reading skills, children born in the fall performed more poorly than did students born in the other 3 seasons. As a whole, students in this group are not only older than their summer-born peers, they are the *oldest* in their grade. Not only was this result unexpected based on the research hypothesis, the direction could not have been more incongruent with it. Additionally, the results reveal similar trends for both SWRE and PDE scores; i.e., subjects born in the fall (September-December) earned the lowest scores on both subtests.

It is of potential interest to note that for New Jersey, the 2-month birth period with the second highest percentage of poor readers on both subtests is January/February. While this does not reflect a fall-born/poor reader trend, it does coincide with the broad assertion that the oldest students obtained the lowest scores. This is because in New Jersey, age of kindergarten entry is a district – not state – level decision. The schools comprising the New Jersey sample are in districts where the age 5 cutoff date for kindergarten entry is either October 1 or October 15. Hence, a New Jersey student born in January would be an “older” student relative to January-born Georgia student.

Such results have several implications vis-à-vis extant and future theories of reading achievement. For example, while the TOWRE SWRE and PDE subtests are believed to be measuring unique skills, whatever mechanism is accounting for the fall-born/poor reader trend is operating similarly in each case. In other words, the putative causal factors (e.g., prenatal perturbation, maturational issues, etc.) contributing to these differences may be exerting negative impact on development of both word-level and phonemic-level reading skills in a systematic manner.

While these results are inconsistent with data showing an increased likelihood of LD diagnoses in children with summer birthdates, it is possible that factors contributing to the LD/summer-born phenomena have to do with more general speech/language delays – which also have been shown to reflect summer-born trends – than to factors specific to early reading skills. Further, while seemingly implausible on a surface level, the possibility exists that the mechanisms accounting for fall birthday seasonal differences in other phenomena (e.g., ADHD; Pineda et al., 2007) are operating similarly for early reading achievement. For example, the executive functioning deficits so often accompanying ADHD symptomatology may play a role in fundamental reading skill acquisition. In the current study, no assessments designed to determine ADHD status were given, so it is not possible to determine directly whether this was occurring.

The results of the current study may in fact be consistent with certain aspects of other research. For example, Stipek and Byler (2001) found that children who entered kindergarten at a relatively older age had a modest advantage in academic achievement during the first year of school; however, this advantage disappeared by third grade. Whatever the mechanism, this waning advantage may have been evident in the sample of students comprising the current study.

In general, research investigating the putative influence of relative age on academic performance has yielded mixed results. Some studies have shown that older children have an academic advantage that lasts through the elementary school years (Cameron & Wilson, 1990; Breznitz & Teltsch, 1989), while others have shown that any academic gap between younger and older students fades by the time the children leave elementary school (Bickel, Zigmond, & Strayhorn, 1991; Crosser, 1991). Further, Lincove and Painter (2006) found that younger students perform at least as well as their older cohorts throughout high school and college.

While my results may be somewhat narrow in scope, they may provide additional rationale for expanding the “age of kindergarten entry” debate, which in itself has policy implications. As Meisels (1992) reported, there has been a trend for states and districts to require that children be older when they enter kindergarten; this is a reflection of maturational notions of development wherein it is assumed that time in and of itself will make a child better prepared for the demands of formal schooling (Frick, 1986). However, many child development researchers and theorists have argued that maturity and school readiness can be influenced by a child’s school experiences (Piaget, 1970; Vygotsky, 1978). This approach suggests that immaturity is the result of environmental and/or genetic factors that cannot be ameliorated by an additional year of growth. Rather, schools should provide developmentally appropriate instruction for young children who have diverse backgrounds and experiences (Meisels, 1992). Additionally, Stipek and Byler (2001) described how educators and researchers who criticize the emphasis on kindergarten entry age point out that age is not highly predictive of skills and behavior -- at least not within the narrow age range in question -- and that development is uneven (i.e., there tend to be “spurts”). Other have argued that, from a measurement standpoint, moving the kindergarten entry date only affects the group mean, not the degree of variation in kindergarteners’ academic skills and social behavior.

Some critics have also been concerned that delaying kindergarten entry will only exacerbate socioeconomic differences in academic skill levels, as middle- and upper-income families are more likely to have the financial resources for an extra year of childcare than are low-income families. Ostensibly, this would result in classrooms where the children from low-income families would be disproportionately young. Additionally, as Angrist and Krueger (1992) have stated, educators and policy makers should consider that *overall* educational attainment is related to school entry, because children who enter school at an older age are permitted to drop out after having completed less schooling than children who enter school at a younger age.

While this level of policy debate is outside the purview of this study, its underlying issues have relevance when considering that the purported older student advantage (i.e., summer born) may not be universal across *all* aspects of academic achievement. This calls into question the practice of "redshirting," which ostensibly serves to provide children with an academic edge by allowing them to be the oldest students in their grades. As touched on earlier, this term originally referred to the long-time practice of college athletic coaches, in which college athletes would be held back a year in order to develop physical strength and improve their athletic skills (Katz, 2000). However, as Lincove and Painter (2006) noted, the difference between redshirted athletes and redshirted kindergartners is that the former participate in practice and training during that extra year while the latter do not necessarily receive academic services, particularly if no preschool program is available.

Other factors that are beyond the scope of this investigation may have contributed to the current results. It is a well established fact that, among academic skills, reading achievement shows the highest correlation with intelligence test scores. Cahan and Cohen (1989) examined the effect of amount of schooling versus age on intelligence test scores in young children. They found that schooling – and not other age-related factors – was the major factor underlying an increase in intelligence test scores. More specifically, for 9 out of the 12 intelligence measures given, the effect of 1 year of schooling was larger than that of 1 year of age. Similar results were found by Ceci and Williams (1997). It is possible that children's reading skill differences have less to do with age in grade as opposed to some other educational-related phenomena. That is, children who are old for their grade have not had as much schooling per year of life as children who are young for their grade. As a result, these older children will have had poorer reading skills than might be anticipated merely on the basis of age. Thus, their reading skills are not as developed as they should be when figured by age-based standard scores as was done here. Thus, if anything, the finding that the oldest children born in the fall months have the worst reading skills as a function of month of birth may be indicative of this schooling phenomenon.

Whether this effect of being the oldest occurs based on general lack of extra general reading instructional time per year of life or for schooling reasons cannot be determined. For example, it is not uncommon for teachers to (rightfully) presume that children who are youngest in their grade (summer born) are at risk for certain untoward outcomes, be they short-lived or not. By extension, teachers may feel that their oldest children (fall born) are at an advantage; this would be even more likely if such children show a relatively higher level of maturity compared to their younger classmates. It is possible that, in an effort to ward off any negative age effects in the academic realm, many teachers inadvertently devote more attention or instruction to those younger students. Those who have investigated factors associated with teachers' decisions on child retention have found that the issue of whether or not the child was young for the grade is one of the most frequently identified reasons (NICHD, 2007; Shepard & Smith, 1986). As well, opponents of redshirting have argued that those older children may be treated as if they were less capable than the younger students in the same grade by teachers or classmates (Crosser, 1998). Lincove and Painter (2006) went further to assert that, despite any evidence that older students have an academic edge in elementary school, "redshirting by parent preference or school recommendation is not an effective strategy for improving high school achievement, graduation rates, or college enrollment" (p. 173).

Moreover, since reading – arguably more than any other academic skill – receives the most focus during elementary school, it would not be unusual (based on the possibility of "extra attention") to see that the youngest children perform better than do the oldest on measures of the most frequently taught skills. As Lincove and Painter (2006) have noted, the increased reliance on standardized testing as an accountability tool has put pressure on schools to ensure that young students meet national expectations; this has manifested in downward pressure placed on second graders, first graders, and even kindergarteners to meet high academic standards (Meisels, 1992; Shepard & Smith, 1986). Consequently, there has been an unprecedented level of academic rigor for the youngest school children.

Despite these efforts, the issue of whether or not age of school entry affects long-term academic progress is still a source of debate. The results of the present study do not lend support to the notion that "older is better." Moreover, the lack of consistency in the research literature addressing school readiness may be due in part to the effects of other uncontrolled factors that influence outcomes for the older kindergarten students. These include family and child characteristics as well as previous social and educational experiences in homes, neighborhoods, and preschool programs (Stipek, 2002).

Other issues warrant consideration when viewing the current results. As research such as the present study is contingent on the type and quality of measurement used, it is important to consider that cross-study outcomes may differ depending on reliability of instrument, chosen norms, etc. For example, Alexander and Martin (2004) reported that use of age-based vs. grade-based norms in reading assessment may produce untoward bias in the early elementary school years. They found that tests using distributional norms (i.e., standard scores) that are based on child age will produce age within grade differences. More specifically, this was based on evidence showing that the older children in a grade will obtain lower normed scores than will the younger children, because age effects are substantially less than grade effects. McDonald (2001) hypothesized that seasonal and/or birthdate effects in academic achievement may be a function of the samples from which average scores are obtained and the extent to which they may or may not represent a full range of ability. As is likely the case in many other studies, the scores used in my analyses were obtained at different times of the year despite being placed into a single grade-level group. Such variability is not necessarily delineated in a test's standardized norms.

A similar line of thinking suggests that the enduring seasonal effects observed in academic performance are not based on the scores of individual children but on group statistics, which come from samples of children. From this view, it follows that the focus of examination should not neglect the impact of the samples which provide the scores. As such, the results of the present study may be due to some idiosyncratic feature(s) of the Georgia and New Jersey samples.

This study has several limitations that must be considered. The very nature of season-of-birth data analyses necessitates incremental breakdown of results (e.g., by 12 months) and a concomitant decrease in "sample" size. As shown, collapsing data into 12- month, 6 x 2-month, or 4 x 3 month intervals came at the expense of sample size (and therefore, statistical power). It is acknowledged that the chi-square test is a less sophisticated procedure than that used in many other investigations, and reliance on chi-square statistics increases the likelihood of obtaining significance by chance (Hauschild, Mouridsen, & Nielsen, 2005).

Similarly, the dearth of robust empirical support for many specific season-of-birth effects in various disorders or phenomena is tempered by the paucity of understanding of seasonal effects in the general population (Bolton et al., 1992). This study's hypothesis may have been premature in this respect.

Other limitations include the possible group differences that may have been revealed if additional analyses had been performed to control for any number of other variables. For example, time of testing (i.e., fall, winter, or spring) may have resulted in some heretofore unidentified difference in performance pattern. As noted above, testing for ADHD and intelligence would have helped me to determine the viability of these alternative interpretations in light of my findings.

Perhaps most important is the consideration of the niceties of the TOWRE's age-based norms. One of the problems inherent in standardized testing is the amount of bias that is introduced every time one makes divisions within a particular reference group. In the TOWRE, the age-based norms are broken down into six-month periods. As such, two children of very similar age may earn the same raw score yet very different standard scores on a TOWRE subtest. As an example, consider two first graders: one age 6 years, 5 months and one age 6 years, 6 months, each of whom earns a raw score of 15 on the TOWRE SWRE subtest. The former will earn a standard score of 102; the latter, a standard score of 91. In my study, the older child will be placed in the poor reader category while the younger child will not. In considering my results, it is logical to assume that the oldest in their grade will always be at a "normative disadvantage" relative to their younger classmates. Depending on the particulars of a test instrument's age-based norms, scores used for research purposes may reflect this type of untoward bias. Some investigations may compare scores from tests with very different age-based breakdowns, e.g., 3-month increments, one-year increments, etc. This suggests that one should remain cognizant of potential bias when considering performance level results and concomitant assertions.

In conclusion, while the results of this study were unexpected based on the hypothesis, they may be less of an anomaly than originally considered. Much of the extant research literature involving season-of-birth effects in academic achievement shows that many investigators are forced to report conflicting results, and there are others who have questioned the value of season-of-birth research all together (Bolton et al., 1992). It may be that some of the questions being asked are sources of limitation in and of themselves; i.e., researchers may need to find new ways to operationalize specific season of birth phenomena, or researchers may need to redefine "season of birth" *per se*. Atladóttir et al. (2007) admonished that "arbitrarily" dividing the year into months or quarters leads to a loss of statistical power "either by multiple testing in which 12 separate significance tests are performed or by the use of a single test with 12 categories resulting in a test with 11 degrees of freedom" (p. 244). They described how a day-by-day analysis has advantages over other approaches, although by doing so the very notion of "season-of-birth" effects is altered on a fundamental level. It may be that this method of investigation will result in new ways to described phenomena in question.

Regardless, it is likely that many studies' outcomes have fallen victim to the effects of smaller numbers that accompany the division of data by seasons (or months, or weeks). It may be that season-of-birth research necessitates sample sizes of such magnitude as to often render it prohibitive. Future research efforts should have as a preliminary procedure an investigation into ways to appropriately maximize sample size.

Additionally, this study seems to suggest that many of the potential limitations associated with season of birth research may be relevant in future investigations involving age-of-school-entry policies. These go beyond the issue of sample size but also include matters such as operationalizing definitions (e.g., *seasonal effects, school readiness*), environmental influences, intrinsic factors, teacher/instructional variables, district and state differences, and the level of statistical complexity, to name but a few.

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