WRITTEN AND SPOKEN EXPOSITORY TEXTS IN CHILDREN WITH

PERINATAL STROKE

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This thesis is dedicated to my beloved brother, “Poppies.”
ABSTRACT OF THE THESIS

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Children with perinatal stroke (PS) offer an unusual opportunity to investigate the nature of brain development for language. These children have suffered a cerebrovascular event in the last trimester of pregnancy up until the first month after birth. Most often, a cerebrovascular event results in a considerable lesion affecting one hemisphere. Whereas adults with an acquired left hemisphere lesion often experience a disruption of language function, children with PS do not display the same language deficits as adults with similar lesions. In fact, children with either right or left brain injury show an initial delay in language, but by middle childhood, their spontaneous spoken language is comparable to their typically developing (TD) peers. Moreover, in adult stroke patients, language impairments may also be co-morbid with agraphia, an acquired writing impairment. In these patients, agraphia generally reflects their acquired linguistic impairments. To date, language studies in the PS group have primarily focused on spoken language of children up through primary school age. To extend our understanding of later language development and plasticity for language in children with PS, the present study examined the language development in a more challenging discourse context, expository discourse, in both spoken and written modalities. The present study examined written expository texts produced by 28 PS and 28 TD age and gender matched children and adolescents (ages 10-18). The PS group was further divided by lesion side, to assess hemispheric differences: Children with a right hemisphere lesion (RHL) and children with a left hemisphere lesion (LHL). Expository texts were transcribed using Child Language Data Exchange System (CHILDES), and analyzed for both linguistic structure and discourse coherence. Results revealed a developmental trend for the TD group, however. The RHL and LHL group’s performance was more variable showing no significant age group differences on any measures. For the spoken modality, there were no significant group differences on any of the linguistic and discourse measures. However, for the written condition of the task, significant group differences were apparent in the following measures: Number of propositions produced, proportion of morphological errors committed, and overall text quality. For the number of propositions produced, the children with RHL produced fewer propositions compared to their TD peers. For proportion of morphological errors committed, the children with LHL committed proportionally more morphological errors than their TD peers. Finally, for overall text quality, the children with a RHL had lower scores implying a less cohesive and developed text compared to their TD peers. In general, these results reveal that the significant differences that were found among the PS group were subtle, yet reflective of the adult stroke lesion profile. Therefore, whereas previous studies show a profile in which early impairment resolves with age, when
confronted with a more challenging task, subtle impairments that mirror the adult stroke profile are revealed. These findings thus support the notion of hemispheric biases for language.
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CHAPTER 1

INTRODUCTION

Past research on children who have sustained early focal brain injuries provide insight for understanding how an insult to the brain impacts behavioral, motor, and cognitive development as well as its effects on the brain’s development in the face of injury (e.g. Ballantyne, Spilkin, Hesselink, & Trauner, 2008; Feldman, 2005; Lidzba, Wilke, Staudt, Krägeloh-Mann, & Grodd, 2008; Reilly, Bates, & Marchman, 1998; Reilly, Losh, Bellugi, & Wulfeck, 2004; Stiles, Stern, Trauner, & Nass, 1996). Within the context of language development, studies have focused on questions of neural and behavioral plasticity, many concerning the distinctively different outcomes between children and adults who have suffered cerebral infarcts/strokes. Early research had generally concluded that early focal brain injury is less likely to result in long-term language impairment than if the injury had occurred in later childhood or adulthood (Basser, 1962; Bates et al., 2001; Lenneberg, 1967; Stiles, Nass, Levine, Moses, & Reilly, 2010; Stiles, Reilly, Paul, & Moses, 2005). While it is understood that early brain injury is likely to result in a more favorable outcome than in adults with comparable insults, a number of studies have also found that some linguistic impairments may be revealed in later development (Ballantyne, Spilkin, & Trauner, 2007; Dick, Wulfeck, Krupa-Kwiatkowski, & Bates, 2004; MacWhinney, Feldman, Sacco, & Valdés-Pérez, 2000). The primary goal of this study is to examine the development of spoken and written discourse, specifically, expository texts from older children with perinatal stroke (PS), with the purpose of investigating later language development and providing further insight into the developing brain.

A number of studies have focused on spoken language and visuospatial performance among children with perinatal stroke (PS); these studies tend to focus on younger children (Akshoomoff, Feroletto, Doyle, & Stiles, 2002; Chilosi et al., 2005; Feldman, 2005; Marchman, Miller, & Bates, 1991; Reilly et al., 1998; Reilly et al., 2004; Stiles et al., 1996; Stiles et al., 2005). Few, if any studies have examined this population’s spoken and written performance on a complex discourse task, such as expository texts. To evaluate later
language development in the PS group, we are addressing three questions: What will expository discourse performance reveal about later language development of children with PS compared to their typically developing (TD) peers? Will hemisphere specific profiles appear? What is the relation between spoken and written language in the PS group and how does it compare with that of the control group? Finally, this study will explore possible limitations of plasticity for language in later development by investigating the production of both oral and written expository discourse in children with PS.

**CHILDREN WITH PERINATAL STROKE**

Perinatal Stroke (PS) is defined as a cerebrovascular event that occurs in the last trimester of gestation until the first month after birth. The prevalence of PS is estimated at one in 4,000 births per year, however given that there are variations in defining and diagnosing this disorder, this estimated rate may be low (Lynch, 2009; Lynch, Hirtz, DeVeber, & Nelson, 2002). Perinatal stroke most often results in a significant lesion that affects one hemisphere, most often the left (Lynch et al., 2002). The outcome of such an event generally has an effect on various behavioral, motor and cognitive functions. The development of the PS population has been of interest in many studies, as an opportunity to understand brain development.

**ADULT BRAIN ORGANIZATION FOR LANGUAGE**

Traditional work on brain mapping and functional localization has generally referenced the brain injured adult profile as a model for understanding the organization of the brain. Conversely, animal models as well as studies investigating PS development have shown that following early focal brain injury, alternative patterns for particular functions develop, thus facilitating a better cognitive and behavioral outcome (Bates et al., 2001; Kennard, 1936; Libzda et al., 2008; Reilly et al., 1998; Reilly et al., 2004).

Since Broca’s (1861) observation of patients following left hemisphere (LH) damage, it has been recognized that the left hemisphere of the brain plays a significant role in language functions. Aphasia is a disorder that is characterized as a “severe disruption of language function due to neurological injury” (Dronkers, Baldo, & Larry, 2009). Adults with injury to the left frontal lobe (Broca’s area) often display impairments with language production. Furthermore, adults with focal brain injury specifically to the LH posterior
temporal region of the brain (Wernicke’s area) often exhibit lexical and semantic impairments for comprehension and production (Dronkers et al., 2009).

Damage to a particular hemisphere of the brain plays an important role in the outcomes of adult linguistic abilities. The left hemisphere is generally recognized as the dominant mediator for language, responsible for components such as phonology, syntax and semantics. However, studies of adults with a right hemisphere lesion (RHL) have shown subtle language production impairments, thus implicating the right hemisphere in selective language functions. A RHL in adults’ generally spares grammatical functioning but can affect discourse in the processing of emotion, prosody and non-literal language (Joanette & Goulet, 1990, 1994; Jung-Beeman, 2005). In discourse production, adults with a RHL often have difficulty following conversational rules, display impulsive responses, focus on irrelevant detail and have a tendency to deviate from the topic; their discourse also often lacks a unifying theme or idea (Campbell & Keith, 2006; Lundgren, Brownell, & Keith, 2006). Joanette and Goulet (1990) found that in narrative discourse, adults with a RHL produced narratives that were less cohesive and provided less information that was different when compared to controls. However, results of this study have revealed variation within the RHL group, showing some performed somewhat like controls. This variation suggests the possibility of subgroups within RHL adults (Joanette & Goulet, 1990, 1994).

Aphasia in adults may also be co-morbid with agraphia, an acquired writing impairment. With agraphia, site and side of the lesion most often affects the type and severity of writing impairments that are expressed (Lorch, 1995). Early research by Goodglass and Hunter (1970) examined writing impairments in adults with acquired aphasia and found that their writing impairments were reflective of their linguistic impairments. Other research has noted that adults are further impaired in writing than in spoken language comprehension or production (Shewan & Henderson, 1988). This research also suggests that writing is often the last skill to recover. A right hemisphere lesion may reveal writing impairments (spatial agraphia) that depict omission or replication of letters within the spelling of words, writing that is crowded onto the right side of the page, or errors in the beginning of words due to visuospatial impairments (unilateral neglect) (Lorch, 1995). These findings among adults who have suffered a stroke raise questions regarding language and writing in the developing brain. For instance, when given a challenging language task, such as the production of
expository texts, what will written discourse performance reveal about later language development in children with PS?

**PERINATAL STROKE PROFILE FOR LANGUAGE**

Current research on the early development of language has shown that children with (PS) left temporal damage do not exhibit comprehension impairments as observed in adults with similar lesions; rather they were more delayed in lexical production and grammatical production than their TD peers (Bates et al., 1997). Furthermore, unlike adults whose language deficits are often permanent and more severe, children with PS generally exhibit an initial delay in early language acquisition, followed by an improvement in functional language abilities by late pre-school, regardless of site of injury (Ballantyne et al., 2007; Bates et al., 1997; Reilly et al., 2004).

Studies on the organization of language in the brain have generally attributed the child’s ability to achieve an almost normal linguistic outcome to the developing brain’s plastic ability to compensate for injury (Chilosi et al., 2008; Libzda et al., 2008; Staudt et al., 2002). Lenneberg (1967) and Basser (1962) were among the first researchers to apply the concept of (neuro) plasticity to language. They had recognized that children who experienced brain injury at an early age did not exhibit the same irreparable impairments as did adults with comparable injury. These observations inspired Lenneberg’s (1967) notion of equipotentiality, that the two hemispheres of the young brain were equally capable of assuming language functions and that lateralization to the left hemisphere progressively developed during maturation; suggesting that there may be a left hemisphere bias for language (Chilosi et al., 2008). Early research by Geschwind and Levitsky (1968) suggested that the anatomical asymmetry in the planum temporale of the adult brain and neonates provides evidence for the idea of the left hemisphere bias for language. Studies have also found that a left lateralization of speech perception is already evident in three-month-old infants (Dehaene-Lambertz, Dehaene, & Hertz-Pannier, 2002). In studying the development of lateralization in normal children using MEG, Ressel, Wilke, Libzda, Lutzenberger, and Krageloh-Mann (2008) found a significant increase of language lateralization to the left hemisphere up through adolescence for both a verb generation task and vowel identification task in typically developing children. Wood et al. (2004) also found similar results using
functional magnetic resonance imaging (fMRI). Furthermore, studies of children with a congenital focal lesion have shown a delay in language development despite lesion side, suggesting that language acquisition involves both hemispheres of the brain (Chilosi et al., 2008; Marchman et al., 1991; Reilly et al., 1998; Reilly et al., 2004; Thal et al., 1991).

In general, studies looking at the development of language in the PS population have shown that they are initially delayed in language development and tend to have early language acquisition problems that are more prominent before the age of five years. A study by Marchman et al. (1991), found that infants with PS (both RHL and LH lesion) were delayed in the onset of babbling as well as delayed in the production of communicative gestures through the age of two years. Furthermore, studies have also found that before the age of five, lesion laterality has an effect on language development (Bates et al., 1997; Vicari et al., 2000). A study by Bates et al. (1997) investigated the emergence of language in children with PS and noted an overall delay in the PS group. They also found that from ages 10-17 months, children with right hemisphere damage showed greater delays in word comprehension, as well in communicative gestures. In contrast, from 19-31 months children with damage to the left temporal lobe were delayed in vocabulary production. Research by Thal et al. (1991) found similar results when looking at children with PS ranging between 12 and 35 months of age. Further research looked at the production of vocabulary within a group of children with PS (15 to 48 months of age) and found an initial delay in the PS group overall, however there was a range of variability in performance when compared to their TD peers (Feldman, Holland, Kemp, & Janosky, 1992). Overall, these studies demonstrate that regardless of lesion site there is a delay in language acquisition. These findings show that early language development in children with PS have specific patterns that differ by lesion site, however these deficits do not map onto the adult stroke profile and seem not to persist.

By age four typically developing children have gained proficiency over a majority of the grammatical structures of their language. After five years of age, TD language development displays a continuously growing vocabulary as well as an increase in how and when to use grammatical structures with different forms of discourse (Reilly, Stiles, Fenson, & Nass, 2005). By 5 years of age, children with PS display similar results in language measures of morphology and use of complex syntax when producing free conversation when compared to their TD peers (Bates et al., 2001).
Although these findings may suggest a linguistic performance comparable to TD children, other studies looking at language production in more challenging language tasks reveals underlying deficits. For example, Dick et al. (2004) found that children with unilateral focal brain lesions, ranging from ages 7-18, were delayed in the development of complex sentence interpretation. They also found that the PS group exhibited profiles similar to the younger TD children. A more recent study by Ballantyne et al. (2007), used a standardized test, the Clinical Evaluation Language Function (CELF) and found that a PS group ranging from ages 5-16 years, performed significantly worse than their TD peers. Studies on narrative discourse have also revealed a delay in children with PS on measures of morphology, use of complex sentences and narrative structure. However, by 10 years the PS group fell into the low normal range on all narrative measures (Reilly et al., 1998; Reilly et al., 2004).

While the production of expository text is the focus of the current study, research on narratives, another discourse genre, has provided insight into the differences of how TD children and children with PS process and produce discourse. Studies on the development of discourse have found that by 9 years of age, TD children are able to distinguish between different discourse genres and tend to use different forms of expression when telling or writing stories about a personal experience than when giving a talk or writing a composition that is focused on a particular topic (Berman & Nir-Sagiv, 2004). Researchers who have studied narrative development have also determined that by age 5-7 years, children tend to produce narratives that follow a canonical structure (Reilly et al., 1998).

Studies by Reilly et al. (1998; 2004) investigated the differences in narrative discourse production in children with PS and TD children. They found that when asking these groups to convey a story while looking at a wordless picture book, the younger PS (4-6 years) group told shorter stories, made more morphological errors and used fewer complex sentences of fewer syntactic types when compared to young controls. An interesting point to note is that the morphological errors of the PS children were similar to those of the younger controls, thus providing evidence of an initial delay in development. However, by mid-school age (10 years), the PS group performed within the low normal range on all morphosyntactic and narrative measures (Reilly et al., 1998; Reilly et al., 2004). These findings demonstrate an initial delay in development followed by the young brain’s ability to compensate and
follow the normal trajectory of linguistic development. It is of interest as to whether this normal trajectory continues when they are asked to produce a more complex discourse such as expository text.

Further analysis of narrative discourse structure found that the older groups of TD children and children with a LHL used more complex syntax, whereas children with a RHL used less complex syntax. According to Reilly, Levin, Nass and Stiles (2008) the use of complex syntax in narratives, functions as a link for different events in the story. Therefore Reilly et al. (2008) concluded that the decrease in complex syntax, along with the increase use of ambiguous pronouns found in a younger RHL group’s interview data may suggest an impairment in discourse cohesion. As mentioned earlier, problems in discourse cohesion are language impairments observed in RHL adults. Therefore, will the challenging task of producing expository discourse reveal such hemispheric differences within the PS group?

Writing Performance in Children with PS

When learning to write, children rely on the spoken language they already know (Sprenger-Charolles & Bechennec, 2004). For typically developing children, the development for writing generally follows a particular course: around the ages of 3-4 years, they are aware of the differences between writing and drawing; by the ages of 5-6 years, children learn the function of the alphabet. The development of written language then follows a series of stages where children learn sound-spelling correspondences, a concept known as the alphabetic principle. By the age of 10 and older, TD children are able to incorporate lexical, morphological and orthographical skills (Ehri, 2000; Treiman & Bourassa, 2000). The focal point in written language is that phonemes map on to the graphic representation. However, unlike other languages, the written form of English is opaque; in that not all sounds correspond to the represented graphemes (Ehri, 2000). In general, Chafe (1994) describes the process of writing as a slow and deliberate process which is less affected by “on the fly” online processing, of speech. Since writing does not have the same time constraints as speech, will this reveal a better performance on the written task than the spoken task for both TD children and children with PS? Will the delayed trajectory seen in spoken narratives be observed in the written task for the PS group?
Research by Aram and Ekelman (1988) and Woods and Carey (1979) used standardized tests to investigate the writing performance of children with PS compared to their TD peers. The findings of these studies revealed that children with LH damage had more difficulty with the written portion of the task compared to those with right hemisphere injured children or controls. However, when looking at both English and French speaking children with unilateral brain injury, Frith and Varga-Khadem (2001) did not find significant differences in spelling performance according to lesion site or age at the time the lesion had been acquired.

A more recent preliminary study by Reilly et al. (2005) investigated the writing development in PS children ranging from ages 8-16. For this study, Reilly and colleagues asked the children to tell a story about a past event (narrative) and to then write the story they had told. This study found that between the PS and TD groups there were no significant differences in the spoken narratives with regards to story length, frequency of complex sentences, complexity of syntax employed or in the structure of the narratives. However, when comparing the two modalities (spoken and written) overall, they found differences between the spoken and written version of the personal narratives. The written form of the story was shorter in both groups when compared to the spoken form, however stories of the PS group were significantly shorter than those of the TD group. When analyzing the group differences on measures of syntax and structure, Reilly et al. (2005) found that there were no significant differences in these older children when comparing the two groups on spoken narratives. However, when comparing the written narratives between the two groups, the TD group performed slightly better than the PS group. These results allude to the challenges that writing presents to this PS population.

The results of the written narrative in the Reilly et al. (2005) study may be reflective of a slowing in development. Levine, Kraus, Alexander, Suriyakham, and Huttenlocher (2005) also observed a deceleration in longitudinal IQ in children with PS. In this study, they found that over the course of development the PS group displayed a further (lower) deviation from the normal control group as time progressed (such that normal controls displayed a steeper slope of IQ development while the PS group was leveling off). Levine et al. (2005) suggested that the decline in IQ scores may be attributed to an increase in task demands and the possibility that the children with PS were unable to sustain the same IQ performance in
the face of higher demands. They also hypothesized that the IQ decline may reflect the limitations of plasticity and that the injured brain may be unable to maintain a rate of development comparable to controls. Taking these results into consideration, the limitations to plasticity may provide an explanation for the narrative writing results of the PS group in the Reilly et al. (2005) study. Moreover, this limitation and slowed trajectory may also be reflected in the expository writing of the PS group in the current study as well.

**Visuospatial Outcomes Subsequent to Perinatal Stroke**

The development of visuospatial processing following unilateral injury reveals that children with PS manifest deficits in spatial cognitive processing in which (hemisphere) side is a significant factor in the type of visuospatial impairment expressed. Studies of children with PS show visuospatial impairments that are similar, yet milder than those observed in adults (Akshoomoff et al., 2002; Stiles et al., 1996; Stiles et al., 2005). Like adults (e.g. Delis, Roberston, & Efron, 1986), children with a RHL have difficulty with global processing, while injury to left hemisphere results in difficulty with local processing (Stiles et al., 2005). These outcomes of visuospatial impairments amongst children with PS suggest that this particular processing system is established early in development compared to language. Although children with PS are able to compensate and display a steady improvement in development, they continue to maintain these subtle deficits throughout adolescence. Stiles et al. (1996) studied a group of children with PS at different developmental periods and found that during a block construction task, the children with PS were able to construct the same model as the TD children. However, when looking at how they constructed their model, the PS children utilized a different approach and had simpler construction procedures. Further studies using the Rey Osterreith Complex Figure (ROCF) had revealed similar findings, in that children with PS used different processes (a piecemeal strategy) to reproduce the figure than their TD peers. They also showed hemisphere-specific differences that were reflective of their impairments on the memory condition (Akshoomoff et al., 2002). Since the modality of writing brings language into the visuospatial domain, it will be of interest to see if this alternative visuospatial processing will have an influence on the PS group’s writing performance.
EXPOSITORY TEXTS

Many studies on the linguistic development of children with PS have generally focused on younger children, standardized language tests, free conversation or narratives; there is little on written discourse and to our knowledge, none on expository texts. In general, expository texts are a more challenging task to comprehend as well as to produce than a narrative. The general purpose of expository discourse is to build a thematic structure in the reader’s mind (Britton, 1994). Expository texts provide information or present ideas about an issue (Tolchinsky, Johansson, & Zamora, 2002). This form of discourse tends to outline an argument or an explanation by describing a set of ideas, claims and arguments that are logically interrelated in order to convey propositional information (Berman & Nir-Sagiv, 2007). Whereas narrative texts focus on characters and actions, an expository text lacks characters or highly structured events, rather it is focused around the theme. Expository texts are often limited to more specific environments, such as an academic setting (Mar, 2004; Tolchinsky et al., 2002).

Many discourse genres consist of a beginning, middle and an end; however different discourse genres are formed by a specific discourse structure. Narratives tend to follow a temporal structure that is organized linearly. On the other hand, expository texts tend to combine content and organization, so that the discussion is dependent on the flow of the information as well as the logical consistency of how the information is conveyed (Berman, 2008; Berman & Katzenberger, 2004). Various studies on expository discourse recognize at least three functionally distinct components that are characteristic of expository texts, these include: (1) an introduction: which presents the topic, (2) a body: which expands on the idea of the topic and (3) a conclusion: which is provided at the end, bringing the topic and its ideas to a close (Tolchinsky et al., 2002). “Moves,” within the expository, are the different steps in which the discourse shifts pieces of information in order to introduce new topics and subtopics throughout the text (Britton, 1994; Tolchinsky et al., 2002). Based around the theme or topic, “moves” are produced in expository discourse, to communicate the theme and permit its reconstruction in the reader’s or listener’s mind. “Move-on” statements or “core propositions” are expanded with the use of examples, reasons, explanations or paraphrases that complete, define, or illustrate the meaning of generalized propositions that are used to present the topic (Britton, 1994).
Expository discourse has yet to be studied within the PS population, however there has been some research on this genre among TD children and adults. Tolchinsky and colleagues (2002) studied the opening and closing elements of narrative and expository texts to determine whether they function as defined boundaries and fulfill a specific discourse function with respect to the text as a whole. The texts in this study were produced by participants from grade school to university level and were divided by modality (written vs. spoken) and genre (narrative vs. expository). The results of the study indicated that across modality and genre, there was a significant increase with level of schooling and the proportion of text dedicated to openings and closing; that is, the young group produced significantly smaller openings and closings in relation to the text as whole, when compared to the older group. The study also concluded that the ability to open expository texts with a direct reference to the topic, through an introduction, emerges later in development.

According to Berman and Katzenberger (2004) the challenges in producing expository discourse can be attributed to the heavy cognitive demands that it requires, specifically in terms of how the information that is to be conveyed is organized and structured. Berman and Katzenberger’s (2004) analyzed text openings for narratives and expository discourse based on three dimensions (discourse functions: providing background in narratives and introducing the topic in expository text; organizational pivot: temporality for narratives and generality for expository texts; and linguistic forms) across groups of school children who ranged in age from 9 to graduate level university students. They found that there was an apparent difference between younger children and mature speakers-writers when looking at their ability to take on different perspectives on issues, to develop ideas on a socially relevant topic, to generalize on the topic and to relate it to personal experience. From this study’s results they concluded that the younger children’s expository texts reflected that they were not yet able to deal with the cognitively complex demands of interweaving specific incidents with general comments on a topic. They also found that the younger groups’ discourse skills were less developed in the ability of incorporating various “move-ons” within the text.

Based on the past research and findings among TD children/students, we can conclude that expository texts are complex and cognitively demanding. We can also assume that expository discourse is dependent on school based experiences, and performance on such
tasks improves with age. Therefore, using such a cognitively demanding task may help reveal the subtleties and complexities of later language development and test the limits of the brain’s neuroplasticity for language.

**Purpose of the Study**

The production of expository texts in written and spoken form represents a late development and potential challenge to the impressive profile of development in spoken language in the younger children with perinatal stroke. Previous language studies in this population have focused on earlier language development and more common forms of spoken discourse. While studies generally report that there is a more favorable outcome for children who sustain brain injury early in life than those who acquire lesions during adulthood, others have revealed subtle impairments during later development.

The present study seeks to explore the developmental performance of children who have acquired a unilateral perinatal focal lesion alongside TD children on the challenging task of producing an expository text, in two modalities: spoken and written. The goal of this study is to investigate later language development in children with PS. The broad question to be addressed in the present thesis is: Will producing an expository text, in both spoken and written form, reveal the limitations of plasticity within this PS group?

To address the main question these subsidiary questions will be addressed:

1. What will expository discourse performance reveal about later language development in PS children compared to their TD peers?
2. What is the relation between spoken and written language in the PS group, and how does it compare with that of the control group?
3. Will hemisphere–specific impairments appear when challenged with expository written and spoken discourse production?

**Hypotheses**

Developmentally, studies on narrative discourse have shown that both groups of TD children and children with PS show increases in both the frequency and type of complex sentences used as they progress in age (Reilly et al., 2004). These studies have also found fewer morphological errors overtime, implying an improvement with the progression of age. Expository texts are a more cognitively demanding genre of discourse. Research on TD participants found that when looking at expository text openings and closings, the young
group dedicated less to their openings and closings in relation to the text as whole, when compared to the oldest group (Tolchinsky et al., 2002). Further research, has shown that a young group of TD students had more difficulty incorporating various moves and producing generalizations and concrete examples within their expository (Berman & Katzenberger, 2004).

**Hypothesis 1:** It is hypothesized that there will be a main effect of age, in that the older group of TD children and PS children will use more complex sentences, have fewer morphological errors, produce longer pieces of discourse and have more complete expository texts as measured by moves within the discourse and the quality of the opening.

As previously mentioned, studies looking at language production using more challenging spoken language tasks have revealed underlying linguistic impairments in children with PS when compared to their age matched TD peers (Ballantyne et al., 2007; Dick et al., 2004; Reilly et al., 1998; Reilly et al., 2004). Studies on language development have shown that children with PS sometimes reflect a delay in their development which is comparable to that of their younger TD peers (Reilly et al., 1998; Reilly et al., 2004). Further studies on IQ and writing also indicate a slowed trajectory, in which TD children performed better than the children with PS (Levine et al., 2005; Reilly et al., 2005). Together, these findings show that language acquisition for children with PS is not completely disrupted, but rather slowed down. Based on these past findings, it is expected that these children will continue to manifest a delay in language development, especially in face of a challenging task such as expository (discourse) production.

**Hypothesis 2:** It is hypothesized that the performance of the PS group will be inferior to that of their TD peers on both linguistic structure measures and discourse coherence measures, and will reveal a delay in PS language development when compared to their TD peers for both spoken and written modalities.

Evidence from a preliminary study by Reilly et al. (2005) had found that in a narrative writing task children with PS performed poorly compared to their TD peers. Studies on visuospatial impairments in children with PS also reveal that they continue to maintain subtle deficits that mirror those of the adult stroke profile as well as process visuospatial differently compared to their TD peers. Taking into account the previous findings that show a poorer performance on a written task as well as persistent visuospatial deficits, it is
reasonable to hypothesize that the TD group will perform better than the PS group for the written portion of the expository production task. Furthermore, a study on IQ has also shown a decelerated progression when children with PS have been confronted with a more challenging task (Levine et al., 2005). As previously discussed, this slowed trajectory may be reflected in the PS groups’ writing performance as seen in the Reilly et al. (2005) study.

**Hypothesis 3:** It is hypothesized that both TD and PS groups will display a better performance on spoken than written expository discourse.

Although studies on PS later language development have not found hemisphere-specific differences, it may be that the tasks used within many of these studies have not been as cognitively challenging to reveal such differences. Given that past developmental literature implicates both hemispheres in normal language development, it may be that differences in types of language impairments based on lesion site may be present. Since we have only adult literature on which to base our hypotheses, it is expected that production of expository text in both spoken and written form, will reveal a similar pattern of right-left hemisphere language impairments.

**Hypothesis 4:** It is hypothesized that children with left hemisphere injuries will show subtle impairments on measures of linguistic structure compared to those with injuries to the right; whereas children with right hemisphere injuries will be selectively impaired on measures of discourse coherence.
CHAPTER 2

METHOD

This chapter discusses the method used in this study, including participants, task, and procedures.

PARTICIPANTS

Participants consisted of 28 children with PS, ranging in age from 10 to 18 years and 28 typically developing (TD) children matched for age, gender, and social economic status. Within the PS group, 12 had RHLs and 16 LHLs. All participants in the study were part of a longitudinal study for the Project for Cognitive and Neural Development in San Diego, CA. All children had normal hearing, normal or assisted vision, an IQ within the normal range and were monolingual in English.

The criteria for inclusion in the PS group included: a single unilateral focal lesion in the absence of other, more diffuse pathology. The lesion with the PS group must have occurred within the last trimester of gestation or within the first four weeks after birth as indicated by Magnetic Resonance Imaging (MRI) or Computed tomography (CT) scan. The TD group had no history of developmental delay and was neurologically intact, as confirmed by neurological assessments.

In order to understand the development of producing expository texts, the children were split into two age groups: 10-13 and 14-18 years. The groups were divided based on the on education levels (grade school and middle school vs. high school). As previously mentioned, expository text, unlike narratives, are mainly experienced in an educational setting.

PROCEDURE

Production of a spoken and written expository text was utilized to investigate later language development in children with Perinatal Stroke.
Task: Spoken and Written Expository

For the Spoken Expository task, children were asked by the experimenter to give a speech on a particular topic. The experimenter verbally provided the following instructions, “I want you to pretend that you are the teacher of a class and you are giving a speech to the students at your school. I want you to talk to them about problems and conflicts between people and what can be done about them. When you are ready please begin your speech.” The child then gave their speech.

Immediately after the child had verbally produced their speech, the experimenter then gave the child the following instructions, “I want you to write an essay on problems and conflicts between people and what can be done about them, just like you talked about in your speech. You can take some time to think about it. When you are ready, just start writing, if you make a mistake or want to change something, just cross it out and continue writing. We have some scratch paper if you want to make some notes or an outline first.” The experimenter was advised to assist the child if necessary by prompting him/her with the following statement, “How are problems started and solved?” When the child was finished, he/she was given a green pen and the chance to revise the written speech. Following the conclusion of the speech and corrections, the experimenter asked the child to read aloud what he/she had written, in order to clarify what the child had intended to write.

The children were recorded with an audio cassette recorder and video recorder while performing the task. The audio cassette was used to transcribe, in CHILDES (Child Language Data Exchange System) format (MacWhinney et al., 2000), both the spoken version of the speech and the read back of their written version. Transcribers used a computer word processing program to create a “mirror” of the written description exactly as it had been written on the page, including all the errors and corrections made.

Coding Conventions

Spoken and written texts were coded at both the micro (linguistic) and macro (discourse) levels. The linguistic structure coding criteria were modeled after Reilly et al.’s (1998; 2004) measures, which include: length, morphological errors and use of complex syntax.
The coding scheme for discourse coherence was in accordance with Tolchinsky et al.’s (2002) measures, which include: position/stance, types of moves and overall text quality. Refer to Appendix A for linguistic and discourse coding sheet.

**MEASURES OF LINGUISTIC STRUCTURE**

**Overall Expository Length:** Using the frequency (FREQ) program of the Codes for the Human Analysis of Transcripts (CHAT) coding system (MacWhinney et al., 2000), the total number of words and word tokens were calculated for each child’s expository. These figures were then used as denominators for more detailed explorations of lexical production. The word lists generated in FREQ were also used to derive an estimate of total number of nouns and total number of pronouns, were used as denominators in specific analyses of pronoun, which will be explained further.

The total number of propositions used by each child was tallied; a proposition is defined as a verb and its arguments. From a semantic perspective a proposition corresponds to a single event. Each clause in a compound or complex sentence was considered to represent one event, and therefore one proposition. For example, the utterance of “It’s better to talk about it,” counted as two propositions. In contrast, “Just leave them alone” was counted as one proposition. Pauses and intonation contours helped to mark propositional boundaries. We then tallied the number of relevant propositions (that do not diverge from the topic) in each child’s expository.

**Morphological Errors:** All errors of commission or omission were tallied. Subcategories included: errors in pronouns; verb auxiliaries; determiners; noun plurals; errors in verb tense; number markings and prepositional errors. Proportion of Morphological Errors was calculated as a ratio of morphological errors to total number of propositions.

**Complex Syntax:** Complex sentences are multiple propositions falling within a sentence intonation contour and are categorized according to the following scheme: coordinate sentences; sentences with subordinate adverbial clauses; sentences with verb complements; relative clauses; and passives, both full and “got” passives. The number of complex sentences in a child’s expository was tallied and divided by the number of propositions to yield the Proportion of Complex Syntax.
In addition to the proportion of complex sentences used by a child, it is of interest to look at the types of complex syntax employed; thus the number of different sentence types occurring in an expository will be counted to yield syntactic depth.

**Syntactic Depth**: A measure to evaluate syntactic complexity by weighting complex structures differently based on later language and syntactic development. Each exemplar of an early acquired structure receives a value of 1, whereas each exemplar of a later acquired structure receives up to 5 points (see Appendix B). To compute the score for Syntactic Depth, the total score obtained was divided by the total number of complex sentences in the child’s story to obtain an index of syntactic complexity.

**MEASURES OF DISCOURSE COHERENCE**

**Self- Sustainability**: is a measure that refers to the speaker/writer’s ability to develop a text monologically without the need of external prompts or inquiry. Self sustainability for spoken texts was measured by the number of utterances participants were able to produce without any prompting from the interviewer and by the number of utterances the interview had to produce in order to get the participants started. Children that were unable to produce two self-sustained utterances were excluded from further analyses. Self sustainability for the written productions will be established by counting the number of text lines.

**Text openings**: the opening segment is the first T-unit, a main clause and any subordinate clauses that are attached (Hunt, 1970). This was considered as an indicator of discourse stance, the position from which the speaker/writer approaches the introduction of the topic in the text. Tolchinsky et al. (2002) defined four categories for positioning:

1. Synoptic positioning: This occurs when participants produces a general statement about facts, conflicts and/or problems. This statement is beyond a description of a concrete situation. It is topic-oriented, and implies a knowledge based attitude and a general reference. For example: “Um… today I’ve been asked to talk about problems and conflicts that can happen between people and how we can deal with them and solve them.” (TD, female, 17 years old)

2. Episodic positioning: This involves cases where the participants begins (or ends) the text by relating it to a particular event or circumstance. It is topic-oriented, but focuses on a particular event or example. For example: “One problem at our school is that some kids smoke.” (PS, male, 17 years old)

3. Contextual positioning: This includes cases where the subject plays the role of a teacher but the topic is unrelated to the one required in the elicitation procedure, it
implies a neutral attitude and specific reference. For example: “the student in the class sitting on the desk ready take out one pencil and eraser?” (PS, female, 17 years old)

4. Prescriptive, evaluative positioning: This involves cases where the subject expresses the text in a manner that is oriented to the audience, referring to direct consequences, recommended behavior or reactions, more specific reference. It reflects a deontic attitude and relies on use of necessary forms. For example: “if you have a problem between two people then you should tell a teacher or a grown up nearby or talk it out.” (TD, female, 12 years old)

Types of Moves: A further analysis included in Tolchinsky et al.’s (2002) coding criteria were moves, a measure that was modeled after Britton’s (1994) analysis of expository text. Moves are units of information and are characterized based on the information that is presented in the text. The following types of moves were adapted from Tolchinsky et al.’s (2002) study and were used for this study as well:

1. Move-On: This type of move is usually used during the introduction by presenting a topic, character, event or object. From this move, new conceptual nodes, topics, or subtopics are opened. This type of move constitutes the core elements of information in the text.

2. Expand: This move is the basic expository move, which includes a process of unfolding, spelling out, illustrating, and giving details of the information that has already been presented. These processes are not core elements, but descriptive, qualifying, explanatory elements within the text.

3. Unifying: This type of move is important for understanding expository text. It is used to summarize a section of the text that has already been presented. This move rarely serves to open Expand and Move-on moves.

4. Ancillary: This type of move includes phrases that initiate, complete, or follow the expository movement, but does not add any core or additional information to the topic. The can be very general or specific.

5. Unfinished: This type of move includes those that remain incomplete in spite of the speaker advancing in the text. Hesitations were not considered Unfinished moves since they are usually produced in speech flow.

Overall text quality: is a measure of discourse coherence that takes into account the number of different moves presented within the discourse.

Level 1: includes texts with only one type of move which either provides a piece of new information without any justification, explanation, example, etc., or only provides an example or opinion, but without introducing the piece of information in which the explanation or example is based on. Texts that presented two types of moves but contain more than two Ancillary moves or unfinished.
Level 2: includes texts with two different types of moves but without Unfinished moves and containing no more than one Ancillary move. At this level there is already some internal differentiation between functional components and a lesser degree of moves that do not contribute new information.

Level 3: includes texts with different types of moves, without unfinished moves. This is the level of maximal internal differentiation and richness of functional components without moves that do not contribute to the development of the discourse topic.

**RELIABILITY**

A second coder who was blind to the group status coded 25% of the expository texts for reliability; agreement for all measures exceeded 90%.
CHAPTER 3

RESULTS

The nature and extent of later language development in children with PS was analyzed through linguistic and discourse measures. A 3 x 2 x 6 (Lesion Group x Age Group x Measures) Multivariate Analysis of Variance (MANOVA) was performed for all measures of linguistic structure and discourse coherence. As expected, we found a significant main effect for age comparisons (younger vs. older) on measures of syntactic depth spoken, overall text quality spoken, number of propositions written and overall text quality written. Further analyses were conducted to assess whether this trend was seen for each group. When looking at lesion group (LHL vs. TD vs. RHL) differences, no significant differences were found for any measures during the spoken portion of the task. However there were significant group lesion differences within the written modality for the following variables: number of propositions written, proportion of morphological errors, and overall text quality. These results suggest that group performance differences were more evident for the written modality than the spoken condition of the task. Further analyses were performed to explore specific group differences using a Bonferroni correction in the post-hoc tests. There were no significant two-way (age group x lesion group) interaction effects for any measure.

Correlations were also conducted to further analyze the relationship between modalities: spoken and written.

To make the data more accessible, the details of the statistical analyses for this study are presented in Table 1 and Table 2. The distributions of linguistic and discourse variables derived from the spoken and written expository texts are provided in Table 3 and Table 4 respectively.
Table 1. Statistical Results for Spoken Linguistic and Discourse Measures for RHL, TD and LHL groups.

<table>
<thead>
<tr>
<th>Test/Effect</th>
<th>Number of Propositions</th>
<th>Proportion of Morphological Errors</th>
<th>Proportion of Complex Syntax</th>
<th>Syntactic Depth</th>
<th>Openings</th>
<th>Overall Text Quality</th>
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<td></td>
<td></td>
<td></td>
<td></td>
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<td>ns</td>
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<td>Group x age F (2, 56)</td>
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</table>

*p < .05

Table 2. Statistical Results for Written Linguistic and Discourse Measures for RHL, TD and LHL groups.

<table>
<thead>
<tr>
<th>Test/Effect</th>
<th>Number of Propositions</th>
<th>Proportion of Morphological Errors</th>
<th>Proportion of Complex Syntax</th>
<th>Syntactic Depth</th>
<th>Openings</th>
<th>Overall Text Quality</th>
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<tbody>
<tr>
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<td>3.09**</td>
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<tr>
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<td>ns</td>
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<td>5.27*</td>
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<td>ns</td>
<td>ns</td>
<td>ns</td>
<td>ns</td>
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</tr>
</tbody>
</table>

Bonferroni Correction

| RHL vs. TD        | -2.86***              | ns                                | ns                           | ns             | ns       | ns                   |
| LHL vs. TD        | ns                    | 2.69***                          | ns                           | ns             | ns       | ns                   |
| RHL vs. LHL       | ns                    | ns                                | ns                           | ns             | ns       | ns                   |

*p < .05

**p = .054

***p < .01
Table 3. Characterizations of Spoken Expository Discourse

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<thead>
<tr>
<th>Linguistic Variables</th>
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<th>RHL M</th>
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Table 4. Characterizations of Written Expository Discourse

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**Age Group Comparisons**

The omnibus MANOVA revealed that there was a significant main effect for age group comparisons on measures of syntactic depth spoken, $F(1, 56)= 6.49$, $p = .014$; overall text quality spoken, $F(1, 56) = 4.15$, $p = .047$; number of propositions written, $F(1, 56) = 6.39$, $p = .015$; and overall text quality written, $F(1, 56) = 5.27$, $p = .026$. Further analyses with a 2 x 4 (Age Group x Measures) Multivariate Analysis of Variance was conducted for each lesion group to assess whether these specific measures showed a developmental trend.
For syntactic depth spoken, the TD group showed a significant difference, $F(1, 28) = 5.25$, $p = .03$, in which the older group ($M = 1.82$) outperformed the younger group ($M = 1.51$). There was no significant age group difference for syntactic depth among the RHL group or the LHL group. A significant age group difference was found for the number of propositions written for the TD children, $F(1, 28) = 6.28$, $p = .019$, in that the older group ($M = 23.43$) had produced more propositions compared to the younger group ($M = 13$). The RHL group showed a trend that was approaching significance, $F(1, 12) = 4.64$, $p = .057$; the older group ($M = 12$) had produced more propositions compared to the younger group ($M = 6.29$) The LHL group had no significant age group differences for the number of propositions produced. For overall text quality written there was a significant age group difference among the TD group, $F(1, 28) = 12.39$, $p < .05$. The older group had higher overall text quality scores ($M = 2.79$) compared to the younger group ($M = 2.14$). No significant age comparisons were evident among the LHL and RHL group. Refer to Table 5 and 6 for Age Comparison performance on both spoken and written expository texts.

Table 5. Characterizations of Age Comparisons for Spoken Expository Texts

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<tr>
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<td></td>
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<td>Older</td>
<td>Younger</td>
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<tr>
<td>Propositions</td>
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<td>Morphological Errors</td>
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<table>
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Table 6. Characterizations of Age Comparisons for Written Expository Texts

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<td>Propositions</td>
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<td>M 23.43 n 14</td>
<td>M 6.3 n 7</td>
<td>M 12 n 5</td>
<td>M 14.14 n 7</td>
<td>M 17.78 n 9</td>
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<tr>
<td>Morphological Errors</td>
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<td>.012 14</td>
<td>.018 7</td>
<td>.024 5</td>
<td>.17 7</td>
<td>.19 9</td>
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<tr>
<td>Complex Syntax</td>
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<td>.71 14</td>
<td>.84 7</td>
<td>.77 5</td>
<td>.61 7</td>
<td>.83 9</td>
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<tr>
<td>Syntactic Depth</td>
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<td>1.84 14</td>
<td>1.4 7</td>
<td>1.54 5</td>
<td>1.37 7</td>
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<th>Discourse Variables</th>
<th>Opening</th>
<th>Overall Text Quality</th>
</tr>
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<tbody>
<tr>
<td></td>
<td>M 1.86 n 14</td>
<td>M 2.57 n 14</td>
</tr>
<tr>
<td></td>
<td>M 2.14 n 14</td>
<td>M 2.79 n 14</td>
</tr>
</tbody>
</table>

**Length of Propositions**

When looking at the number of propositions produced for the written text, there was significant lesion group difference, $F(2, 56) = 4.10$, $p = .022$ (see Figure 1). Further analyses, using the Bonferroni post hoc test, revealed that there was a significant difference between children with a RHL and the TD group, $p = .0062$. The TD group ($M = 18.21$) produced significantly more propositions in their written expository texts compared to the children with a RHL ($M = 8.67$). There was no significant difference between the TD group and the children with a LHL for the number of propositions produced. The MANOVA indicated no significant group differences in the children’s spoken expository texts, $F(2, 56) = 1.17$, $p = .32$.

**Morphological Errors**

Figure 2 shows the mean scores for proportion of morphological errors amongst the three groups RHL ($M = .02$), TD ($M = .028$), LHL ($M = .18$) within the written modality. The omnibus MANOVA revealed a significant main effect of lesion for morphological errors committed in the written expository texts, $F(2, 56) = 4.17$, $p = .021$, but not for the spoken. The Bonferroni post hoc test revealed that the LHL group committed significantly more...
morphological errors compared to the TD group, \( p = .0096 \). There was no significant difference between the children with a RHL and the TD group for proportion of morphological errors committed. No significant group differences were found in the proportion of morphological errors committed when looking at the spoken expository task, \( F(2, 56) = .254, p = .78 \) (see Figure 2).

**Overall Text Quality**

In their written expository texts, a main effect of lesion on overall text quality scores was approaching significance, \( F(2, 56) = 3.09, p = .054 \). Upon further analysis, the Bonferroni correction illustrated a significant difference, between the children with a RHL (\( M = 1.92 \)) and the TD (\( M = 2.46 \)) children, \( p = .021 \) (see Figure 3).

**Modality Differences**

A Pearson correlation was conducted to further analyze the relationship between modalities: spoken and written. For the LHL group, there was a high correlation of proportion of morphological errors committed when comparing the modalities of spoken and written, \( r(14) = .78, p = .001 \). The LHL group produced a higher proportion of morphological errors in the written expository texts compared to their spoken texts. This effect was the opposite for the TD and RHL group, who produced fewer morphological errors on their written texts compared to their spoken discourse (refer to Figure 4).
Figure 1. The total number of propositions produced by the three different groups for their written expository texts. The Typically Developing group produced more propositions compared to the RHL group.

Figure 2. The mean scores for proportion of morphological errors produced amongst the three groups for the written portion of the task. The LHL group committed significantly more errors than the TD group.
Figure 3. The average overall text quality scores amongst the three groups for the written expository text. The children with a RHL had lower overall text quality scores compared to their TD peers.

Figure 4. The relationship between modalities: spoken vs. written, amongst the three groups RHL, TD, and LHL. The LHL group displayed a high correlation of proportion of morphological errors committed when comparing the modalities of spoken and written.
CHAPTER 4

DISCUSSION, RECOMMENDATIONS, AND CONCLUSION

Children with Perinatal Stroke provide a unique opportunity to examine the course of brain and language development following an early cerebral insult. Research investigating the development of children with PS has shown that following focal brain injury, these children tend to have a better cognitive and behavioral outcome (Ballantyne et al., 2008; Bates et al., 2001; Libzda et al., 2008; Reilly et al., 1998; Reilly et al., 2004). While studies of the PS group have shown an initial delay in language, by mid-childhood their spontaneous language is comparable to their TD peers (Reilly et al., 2008). Language studies in the PS group have primarily focused on spontaneous language of children up through primary school (Feldman, 2005; Marchman, et al., 1991; Reilly et al.1998; Reilly et al., 2005; Stiles et al., 1996; Stiles et al., 2005). In fact, few studies have examined this population’s spoken and written performance on a complex discourse task such as expository texts. Few, if any studies have assessed the nature and extent of later language development and plasticity within the PS population. This study in particular, assesses the nature and extent of later language development and plasticity within the PS population by examining their performance on a challenging discourse production task in two modalities: spoken and written. Results revealed that the significant differences that were found among the PS group were subtle, yet more reflective of the adult stroke lesion profile than their earlier language. There were no significant differences on the various linguistic and discourse measures among the three groups for the spoken modality. However, for the written condition of the task, significant group differences were apparent in number of propositions produced, proportion of morphological errors committed, and overall text quality. For the number of propositions produced, the children with RHL produced fewer propositions compared to their TD peers. For proportion of morphological errors committed, the children with LHL committed proportionally more morphological errors than their TD peers. Finally, for overall text quality, the children with a RHL had lower scores implying a less cohesive and developed text compared to their TD peers. In general, although we saw no group differences on the
spoken task, children with PS showed significant differences on a subset of linguistic and discourse measures for the written portion of the task that was reflective of the adult stroke profile.

We now turn to our original hypotheses:

Hypothesis 1: The older group of TD children and PS children will use more complex sentences, have fewer morphological errors, produce longer pieces of discourse and have more complete expository texts as measured by moves within the discourse and the quality of the opening.

Analyses confirmed this hypothesis for the TD group, however not all measures followed this trend. The measures that confirmed this hypothesis were within the written modality, showing the older group performing better than the younger group. When looking at the means for the RHL and LHL group’s performance on all measures, neither group followed a consistent developmental trend in which the older group outperformed the younger group. However, the inconsistent trends among the PS group may be influenced by the variability in performance within the RHL and LHL groups. Conversely, the TD group displayed less variability within their group as a whole, thus providing a possible explanation as to why their performance better reflected the hypothesized developmental trend. Whereas the TD group displayed a significant developmental improvement on specific measures, there were no significant differences found within the RHL and LHL, younger and older groups. The challenging task of producing an expository text may have revealed impairments reflecting a deceleration in development, which has been observed in past IQ studies (Levine et. al, 2005). Since there were no significant age group differences within the spoken modality in contrast to the written texts, this confirms that writing presents an additional challenge to this already demanding task.

Hypothesis 2: The performance of the PS group will be inferior to that of their TD peers on both linguistic structure measures and discourse coherence measures, and will reveal a delay in PS language development when compared to their TD peers for both spoken and written modalities.

Hypothesis 2 was confirmed within the written modality, the measures that displayed significance showed that the PS group’s performance was inferior compared to their TD peers. The RHL group produced significantly fewer propositions and had significantly lower
overall text quality scores compared to their TD peers. The children with a LHL also committed proportionally more morphological errors compared to the TD group. However, this hypothesis was not confirmed when looking at the spoken modality, performance on measures within the spoken modality were comparable for all three groups. The differences found on the written condition of the task seem to reveal a subtle reflection of the adult stroke profile. However, the fact that these differences do not appear on the spoken condition indicates that the written portion presents an additional challenge.

Hypothesis 3: Both TD and PS groups will display a better performance on spoken than written expository discourse.

Analyses reveal that only one measure was notably different when analyzing the relationship between spoken and written. The children with a LHL produced more morphological errors for the written portion of the task compared to the spoken condition. This trend was the opposite for the children with a RHL and the TD group. These results seem to confirm past research implicating the left hemisphere as the dominant mediator for grammar (Dronkers et al., 2009). The results also mirror the impairments that are observed in the adult stroke profile.

Although correlations did not show many significant relationships, when comparing group performance within the two modalities, significant differences between the three groups were only apparent for the written expository texts. Measures such as number of propositions produced, proportion of morphological errors committed and overall text quality, showed significant differences between the TD group and one of the PS groups. In each case, the PS groups’ performance was inferior compared to the TD group. In general, the PS group performed comparable to their TD peers on the spoken condition; however they clearly struggled on specific measures during the written portion of the task. These results may indicate the challenges that writing presents when paired with a demanding task, thus revealing impairments that were not observed during the spoken condition.

Hypothesis 4: Children with left hemisphere injuries will show subtle impairments on measures of linguistic structure compared to those with injuries to the right; whereas children with right hemisphere injuries will be selectively impaired on measures of discourse coherence.
While not all measures showed significant group differences, the significant differences that were apparent do confirm our fourth hypothesis. For the written portion of the task, the children with a LHL made significantly more errors than their TD peers; this finding is in line with our hypothesis that children with a LHL will show subtle impairments on measures of linguistic structure. Past studies on adults with a left hemisphere injury tend to show impairments in language production and comprehension, specifically with the more formal aspects of language such as morphology and syntax (Broca, 1861; Dronkers et al., 2009). This profile seems to be reflective of the adult stroke profile who have suffered a comparable injury. When looking at the RHL group’s performance on the written portion of the expository task, the number of morphological errors committed is comparable to the TD peers; thus showing that this aspect of the task was specifically difficult for the LHL group.

One factor to note is that within the PS group as whole, there was a great amount of variability. Specifically within the LHL group, there were four outliers that had more morphological errors compared to the rest of the group; this may have skewed the data. However, we chose not to take these children out since this variability is representative of our population. Refer to Figures 5, 6 and 7.

Figure 5. Writing sample from 11 year old, female with a LHL. This writing sample is an example of an outlier in the LHL group.
Figure 6. Writing sample from 17 year old, female with a LHL. This writing sample is an example of an outlier in the LHL group.
Figure 7. Writing sample from 14 year old, female with a LHL. This writing sample is an example of the variability that exists within the LHL group when comparing it to the previous writing samples.

When looking at overall text quality within the written modality, the RHL group had less fluent and informative expository texts compared to their TD peers. These results also confirm hypothesis four, in that we predicted that the RHL groups would be selectively impaired on measures of discourse coherence. Support for our hypothesis include past studies on adults with a RHL, who produced narratives that were less cohesive and provided less information compared to the controls (Joanette & Goulet, 1994). The results from our study
seem to show that the performance of these children mirror findings of adults with RHL. Therefore, when given a challenging task, deficits are revealed that subtly mirror the adult profile. Such findings provide evidence that the left and right hemispheres have a particular bias for language functions.

The significant differences found between the three groups on the measures were subtle, yet were reflective of the adult lesion profile. The children with a LHL made significantly more errors on the written expository task compared to their TD peers. This finding is reflective of past observations of adults that have had damage to the left hemisphere of the brain. Adults with left hemisphere injury generally exhibit impairments in language production and/or comprehension (Broca, 1861; Dronkers et al., 2009). These impairments most often involve formal language components such as phonology, syntax and morphology, thus implicating the left hemisphere as the dominant mediator for language. The number of morphological errors committed by the RHL group and the TD group were comparable; therefore this problem seems to be specific to the LHL group, providing further support to the possibility that these children are demonstrating a performance that is similar to the adult profile. Furthermore, our findings show that the RHL group had lower overall text quality scores compared to the TD group. The overall text quality measure encompasses discourse cohesion and assesses whether all the components of an expository (e.g. introduction, body, conclusion) are included. These results are also in line with past findings that found that adults with a RHL produced narratives that were less cohesive and provided less information that differed from controls. Interestingly, although these subtle findings were seen within the written modality, there were no significant differences within the spoken modality. Therefore, does writing present an additional challenge to this group that spoken does not?

When looking at the correlations between spoken and writing within each group, there was a significant difference found for morphological errors among the children with a LHL. The LHL group made more morphological errors in the written portion of the task than the spoken. This trend was the opposite for the TD and RHL group. Although there were no other clear correlations between the spoken and written modalities, the fact that more significant differences were found between the groups in the written modality rather than spoken, may reveal that there is something more challenging with producing a written
expository text. The development of spoken language occurs early, such that by age four, typically developing children have gained proficiency over a majority of their language. After 5 years of age, TD language development displays a continuously growing vocabulary as well as increase in how and when to recruit certain grammatical structures for different discourse genres (Reilly et al., 2005). However, the process of learning to write is dependent on the spoken language that we already know; it is an explicitly learned and deliberate process. The development of writing for typically developing children generally follows that, around the ages of 3-4 years, children become aware of the differences between drawing and writing; by ages 5-6 years, children learn the function of the alphabet. By the age of 10 and older, TD children are able to incorporate lexical, morphological and orthographical skills (Ehri, 2000; Treiman & Bourassa, 2000). Because writing is a later acquired skill and dependent on spoken language, it may be a more challenging modality, especially when paired with producing an abstract genre such as an expository text. Another aspect of writing is that it encompasses visuospatial processing. As discussed earlier, children with PS tend to have subtle deficits in visuospatial processing that persist into later adolescence and are reflective of their lesion side and thus mirror the adult stroke profile. Therefore, the challenges of writing may be reflected in our findings.

The results for this study show that the TD children displayed the predicted developmental trajectory (older performing better than younger) on specific measures within the written modality; however the children with PS displayed a more sporadic profile. Past research studying the development of both TD children and children with PS in the production of narratives, has shown increases in both frequency and type of complex sentences with the progression of age (Reilly et al., 2008). These studies have also found fewer morphological errors over time, implying an improvement with the progression of age. The current results seem to show a similar trend for the TD group but not for the PS group. It may be that the challenges of producing the written expository discourse is so difficult for the PS group that their performance does not show a significant difference between the younger and older groups. These results may reflect similar outcomes from an early IQ study by Levine et al. (2005) and a preliminary writing study (Reilly et al., 2005) that indicated a slowed trajectory for the PS group. Together these findings show that language acquisition
for children with PS is not disrupted but rather slowed down as a result of their reduced processing capacity; this is especially prominent in the more challenging writing task.

**RECOMMENDATIONS**

The study of language development in children with PS is of interest as a means to understand brain development for language, as in the distinctively different outcomes between these children and adults who have suffered strokes. Early research has generally concluded that early focal brain injury is less likely to result in long-term language impairment than if the injury had occurred in later childhood or adulthood (Basser, 1962; Bates et al., 2001; Lenneberg, 1967; Stiles et al., 2005; Stiles et al., 2010). However, further studies have found that when given a more challenging task, subtle language impairments that are reflective of the adult stroke profile may reveal itself (Levine et al., 2005; Reilly et al., 2008). Previous language studies within this population have included free conversation through autobiographical interviews and narratives (Bates et al., 2005; Reilly et al., 1998; Reilly et al., 2004). This particular study took a different approach using a more abstract genre, expository texts. Performance in producing different discourse genres reveals different results and uses of language providing us with insight into this particular population’s language development and the extent and nature of plasticity. Performance on structured genres (that can be measured for linguistic and discourse analysis) such as narratives and expository texts help reveal their ability to use language and compose a specific type of text in both spoken and written form. Therefore, a possible future inquiry is to investigate the relationship between their performance on narrative and expository discourse.

The relationship between narrative and expository discourse has been previously studied within the Typically Developing population at the linguistic and discourse level. Studies by Berman and Nir-Sagiv (2007) and Tolchinsky et al. (2002) have studied the relationship between narratives and expository texts in depth in a typically developing population among different age groups. Although these studies used different measures to analyze the different components of narrative and expository texts, they found that there were differences in the way in which discourse was used for each type of genre as well as developmental differences. It may be of interest for future research to analyze the relationship between the two different genres produced within this population and to see how
it maps onto the TD’s developmental performance. Furthermore, it may also of be of interest to perform an in depth analysis as some of these previous studies have done in the TD population and analyze the differences within each measure.

Another fascinating component within this study that may warrant further research is analyzing the PS group’s actual writing within these different discourse genres. Although visuospatial processing was not the primary focus of this study in particular, it may be of interest to analyze the actual writing of these children’s writing. As discussed previously, visuospatial processing in children with PS are similar yet milder than those observed in adults. The development of visuospatial processing following unilateral injury reveals that children with PS manifest deficits in spatial cognitive processing in which hemisphere side is a significant factor (Akshoomoff et al., 2002; Stiles et al., 1996; Stiles et al., 2005). Past studies have revealed that during different developmental periods, these children utilize a different approach in a block construction task compared to their TD peers (Stiles et al., 1996). Given that the modality of writing brings language into the visuospatial domain, it may of interest for future research to analyze this population’s actual writing. By looking at their writing this may further reveal the extent of plasticity within this population and how it may interact with their performance on certain language tasks at different levels of development.

In considering how this study might be improved, study limitations included the number of subjects as well as the variability that existed within the PS group. First, the number of subjects was relatively low. However, taking into account the rarity of this event, we have no reason to believe that this sample is not representative of the PS population. A second limitation is the variability within the PS group. The extent of damage, the area where the lesion is located, and the various routes of plasticity are all factors that create variability within this group. In spite of this, the variability that exists within this population may be of interest for further research to investigate how these particular differences may affect specific areas of language production.

**CONCLUSION**

To better understand the nature and extent of later language development and plasticity within the PS population, this study examined their performance on a challenging
discourse production task in two modalities: spoken and written. Expository texts were used to investigate language development and verified that children with PS show an inferior performance on specific measures within the written modality compared to their TD peers. In considering how the two PS groups use language, we begin to see evidence that the RHL mirror the profile of adults with RH injury and that the children with a LHL are making errors that are reflective of the adult stroke profile. In general, these children’s language development in discourse are displaying a profile in which early impairment resolves with age, to yet again be revealed in more challenging contexts and subtly mirror the adult stroke profile.
REFERENCES


APPENDIX A

CODING SHEET FOR LINGUISTIC AND DISCOURSE MEASURES
Appendix A

EXPOSITORY DISCOURSE CODING SHEET

Subject #: __________  Text type: Spoken [ ]  Written [ ]
Date of Test: ____________  Date of Birth: ____________  Age at Test: ____________
Coder Name and Date: __________________________________________

Self Sustainability:  YES [ ]  NO [ ]  Expository Length: ______  # of Propositions ______

Morphological Errors
a. Pronoun Error (him lost it) __________________
b. Verb Auxiliaries (he O hollering at the dog) __________________
c. Determiners (O dog run father than the boy) __________________
d. Noun Plurals/ Verb Tense Errors (he fall down there) _____________
e. Number Markers (he have his horns stickin' up) __________________
f. Prepositional Errors (he's lookin' up those woods) ________________
1. Comission (total) __________________
2. Omission (total) __________________
Frequency of Morphological Errors: __________________ ( = Total Errors ÷ # of Propositions)

Complex Syntax

Syntactic Diversity
1. Coordinate Sentences (and, or, but) _____________________________
2. Subordinate Adverbial Clauses (when, how, because, so) ____________
3. Verb Complements (say(that)+S; try+V; keep+V; want+V/S) __________
4. Relative Clauses (the boy was calling for the frog that was lost)
5. Passives, both full (the dog's bein' chased by bees) and "got" passives (he got throwed in the water)
6. Other __________________
Frequency of Complex Sentences: ________ ( = Total Complex Sentences ÷ Number of Propositions)
Syntactic Depth Score: ________ ( = Total Score ÷ Total Number of Complex Sentences)

Discourse Structure (yellow):

Opening  Synoptic 3
Episodic 2
Prescriptive/Evaluative 1
Contextual 0

Moves
1. Move-on
2. Expand
3. Unifying
4. Ancillary
5. Unfinished

Overall Text Quality: __________________

Level 1: texts with one type of move, or texts that presented two types of moves but contain more than one Ancillary moves or Unfinished
Level 2: texts with two different types of moves but without Unfinished moves and containing no more than one Ancillary move
Level 3: texts with different types of moves, without unfinished moves
APPENDIX B

SYNTACTIC DEPTH CODING SCHEME
Appendix B

SYNTACTIC DEPTH CODING SCHEME

Verb Complements = 1
But, or, and, and then = 1
So, because = 2
However, where, when, how, if, still = 3
Relative objects = 4
Relatives subjects = 5
As if, as though = 5

Full Passives = 4 (“I was hurt by my brother”)
Agentless = 3 (“I was hurt (by my brother omitted)”)  
Full “got” passives = 3 (“I got hurt by my brother”)  
“Got” passives = 2 (“I got hurt”)

Table 7. Coordinative and Subordinate Conjunctions and Corresponding Raw Scores

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<thead>
<tr>
<th>Scores</th>
<th>Coordinative Conjunctions</th>
<th>Verb complements</th>
<th>Syntactic Structures</th>
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<tr>
<td>1</td>
<td>All coordinative conjunctions e.g., and, but, so</td>
<td>All verb complements e.g., infinitives, gerunds, participles</td>
<td>All coordinative conjunctions e.g., and, but, so</td>
</tr>
<tr>
<td></td>
<td>Agentless got passives e.g., “I got hurt”</td>
<td>So (so that), because</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Agentless be passives e.g., “I was hurt”</td>
<td>however, where, when, how, if</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Full got passives e.g., “I got hurt by my brother”</td>
<td></td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>Full be Passives “I was hurt by my brother”</td>
<td>Still</td>
<td>Object relative clauses e.g., “I yelled at the boy who was hitting my sister”</td>
</tr>
<tr>
<td>5</td>
<td>as if, as though</td>
<td>Subject relative clauses e.g., “The boy I hit came to talk to me”</td>
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</table>