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PHONEMIC PERCEPTION, RECEPTIVE MORPHOLOGY AND PRODUCTIVE MORPHOLOGY SKILLS OF SPEECH DELAYED PRESCHOOLERS

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1. Introduction

In the pre-school years it is predicted that 2.5 % of children have a moderate to severe speech disorder of unknown origin (Shriberg, Kwiatkowski, Best, et. al.1986). This is in contrast to children who have speech disorders of known origin including children with craniofacial dysmorphologies (like cleft palate), mental retardation, and autism (Shriberg, Tomblin, & McSweeny, 1999). Children with a speech disorder of unknown etiology used to be diagnosed as having a "functional articulation disorder", meaning that the cause of the speech sound difficulty was thought to be articulatory however, today we know that these children have problems of speech sound representation, not just difficulties in articulatory precision (Leonard, 1995). Children with problems representing speech sounds do not have adult-like mental representations for the phonemes in their native language, whereas children with articulatory difficulties simply have trouble producing the phonemes in their language. Therefore the preferred terms to describe this organizational problem are "phonological disorder", "phonological disability" or "phonological impairment". While the percentage of children with a phonological disorder (PD) may not appear striking, since these children are at serious risk for many other difficulties, such as reading delays (Bird, Bishop, & Freeman, 1995; Torgeson, Wagner, & Rashotte, 1994; Mann, 1993), understanding the nature of this disorder and its implications is important. Research shows that many children with a moderate to severe phonological disorder may also have difficulties with other areas of language such as morphology, syntax, and the

lexicon (Leonard, 1995). This places PD children at a serious disadvantage compared to normally developing children entering kindergarten.

In recent years there has been a lot of interest in *phonological awareness* with respect to children's ability to decode the written language. Phonological awareness is a person's sensitivity to the phonological structure of words (Torgeson et al., 1994). Although phonological awareness is not fully attained until reading instruction begins, it has been found that preschoolers' metalinguistic knowledge about the phonemes in their language is a strong predictor of later reading ability (Mann, 1993). Children with phonological disorders have been shown to score lower than age-matched controls on many measures on phonological awareness and literacy (Bird et. al, 1995). Bird and his colleagues posit that if children cannot tell two phonemes apart, they will face difficulties in learning how to read and spell. Their study required children to identify whether or not a series of words started or ended with certain sounds. For example in one task the children were presented with words like 'cat', 'mop', and 'bus' and asked if these words began with a given sound like /k/. In another task they were asked to identify if words like these ended in a given sound like /t/. It was found that the PD children had extreme difficulties in carrying out tasks like these that required them to segment and match onsets and rhymes of words. This supports the idea that these children have difficulties classifying and analysing speech sounds which are skills needed to learn how to read and spell.

Considering the importance of phonological awareness in reading ability, and how preliminary research, such as the study conducted by Bird et al., show that PD children have weak knowledge about the speech sounds in their language, it is surprising how relatively few studies have been conducted on the subject of reading development among children who have difficulty with the accurate production of speech sounds. In fact, some

argue that PD children are not at risk for delayed reading development (Catts, 1993); therefore more research in this area is needed.

Traditionally, the treatment of children with PD has focussed on the motor task of correctly producing the misarticulated speech sounds (Shelton & McReynolds, 1979). However, these days it is known that articulation learning is closely tied to the child's underlying knowledge of language-specific speech sound contrasts, which in turn is derived from the child's perceptual ability to accurately segment words into individual phonemes and discover the acoustic cues that differentiate one phoneme from another (Rvachew & Jamieson, 1995). Compared to research conducted in the PD population there has been considerably more research conducted on the role of phoneme knowledge in later reading ability with both normally developing children and children with specific language impairment (SLI). SLI is a linguistic deficit in young children who do not have a corresponding cognitive deficit (Wexler, Schütze & Rice, 1998). These children have age-appropriate phonology, but have significant syntactic and morphological deficits. Research conducted with SLI children and normally developing children shows that the ability to segment words into individual phonemes is an important predictor of reading ability for both these groups of children (Bradley & Bryant, 1983; Torgeson et al., 1994). In other words, it has been found that children who have difficulty segmenting words into their individual phonemes, for instance segmenting 'cat' into /k/, /æ/, /t/, are predicted to have later reading difficulties. Although there is reason to believe that both PD and SLI children are at risk for reading problems, it cannot be assumed that the research with the SLI population can be directly generalized to children with a phonological disorder because the literature suggests that there are different etiologies for these two populations of children (Shriberg et. al., 1999). If fact, comorbidity of speech delay and SLI was found to be only

0.51%. Therefore, studies that examine the relationships between reading and the relevant precursor variables in the PD children are required. As a first step, we need to examine the relationships among phonemic perception, phonological awareness, and articulation in the preschool-aged population.

It is well represented in the literature that children with PD have deficits in phoneme knowledge. These children have mental representations that are lacking in certain distinctive features and therefore they are unable to produce all of the contrastive speech sounds in their language. A few studies also show that in addition to a phonological deficit, children with PD also have other language deficits such as morphological delays (Paul & Shriberg, 1982; Shriberg et. al., 1986). Most of the research on morphological development in children with language disorders has been carried out in the SLI population. Although there are many studies describing the morphology of children with SLI there continues to be controversy about the exact nature of this disorder. Rice, Wexler & Hershberger (1998) reported that verbal tense is especially difficult in comparison with non-tense morphemes, even when phonetic structure is equated. For example, children with SLI typically do not produce morphemes that have the grammatical property of tense marking, like the third person singular –s morpheme in 'she walk<u>s</u>', but they do not typically drop other non-tense morphemes like the plural marker in 'two block<u>s</u>'. In fact it has been found that children with SLI demonstrate a productive and differentiated plural system by the age of five (Oetting & Rice, 1993). The optional use of tense marking morphemes is attributed to an incomplete specification of grammatical tense in the children's underlying mental representations (Rice et al., 1998). Leonard and his colleagues (Leonard & Bortolini, 1998; Leonard et. al., 1997) report that morphemes that have "low phonetic substance" are difficult, regardless of their grammatical function. Morphemes that are low in phonetic

substance are morphemes that are less salient because they are short in duration. For example, Leonard and his colleagues found that children with SLI produce irregular past forms that contain at least a vowel in a strong syllable, like ‘caught’, to the same extent that children with age-appropriate language do. Regardless of what the nature of this language deficit appears to be, it is clearly shown in the literature that receptive morphological knowledge predicts productive morphology for children with SLI (Rice, Wexler, Redmond, 1999). In other words children with SLI, who do not produce certain morphemes, also have difficulty perceiving these morphemes.

In contrast to the large literature describing morphological development in children with SLI, there are very few studies that describe the morphological development of children with a phonological disorder. One of the only studies that looked at the morpheme acquisition in the PD population, Paul and Shriberg (1982) reported that more than half of the thirty preschool-aged children they studied had more difficulty with the production of grammatical morphemes than would otherwise be predicted by their overall level or morphemic ability. The implication is that these problems with productive morphology directly reflect the children’s ability to produce the necessary sounds, rather than the knowledge of the grammatical structures. However, no measures of phonemic perception or receptive morphological knowledge were employed in this study therefore it is difficult to interpret the nature of this apparent morphological deficit in the PD population.

The purpose of this study is to describe the productive morphological skills of children who have a severe phonological disorder, in relation to the child’s phonemic perception abilities and receptive morphology knowledge. The literature up to date has suggested that children with a phonological disorder have poor phoneme awareness and this is an important predictor of later reading difficulties. In addition, preliminary research (Paul

& Shriberg, 1982) shows that children with PD appear to have a productive morphological delay. We know little about the nature of this delay since research on PD children's morphological development is scarce, and the research that has been conducted to date did not examine phonemic perception or receptive morphological knowledge. It is expected that this study will extend Paul & Shriberg's findings by targeting a sample of younger and more severely impaired PD children, and by assessing both perceptual and productive phonological and morphological knowledge.

More specifically this study investigates the role of PD children's phonological perception of the phoneme /s/ on their production of three related morphemes, the plural morpheme as in *two cat*s, the possessive morpheme as in *Mary's cat,* and the third person singular present tense morpheme as in *Mary walks.* These three particular morphemes were chosen because the literature shows that they are acquired at different developmental stages (Brown, 1973; deVilliers & deVillers, 1973)[1]. In addition the children's receptive morphological knowledge will be investigated to see if there is a link between morpheme knowledge and production. It is hypothesized that the PD children will have morphological productions that match their phonemic perceptions. In other words, children with poor phonemic perception will show a productive morphological deficit. Also as it was shown in Paul & Shriberg's study, it is predicted that the PD children will attain a lower stage for grammatical morphemes than age-appropriate and that they will make more morphological production errors than should otherwise be predicted by their overall morphological ability.

2. Classifying Phonological Disorders

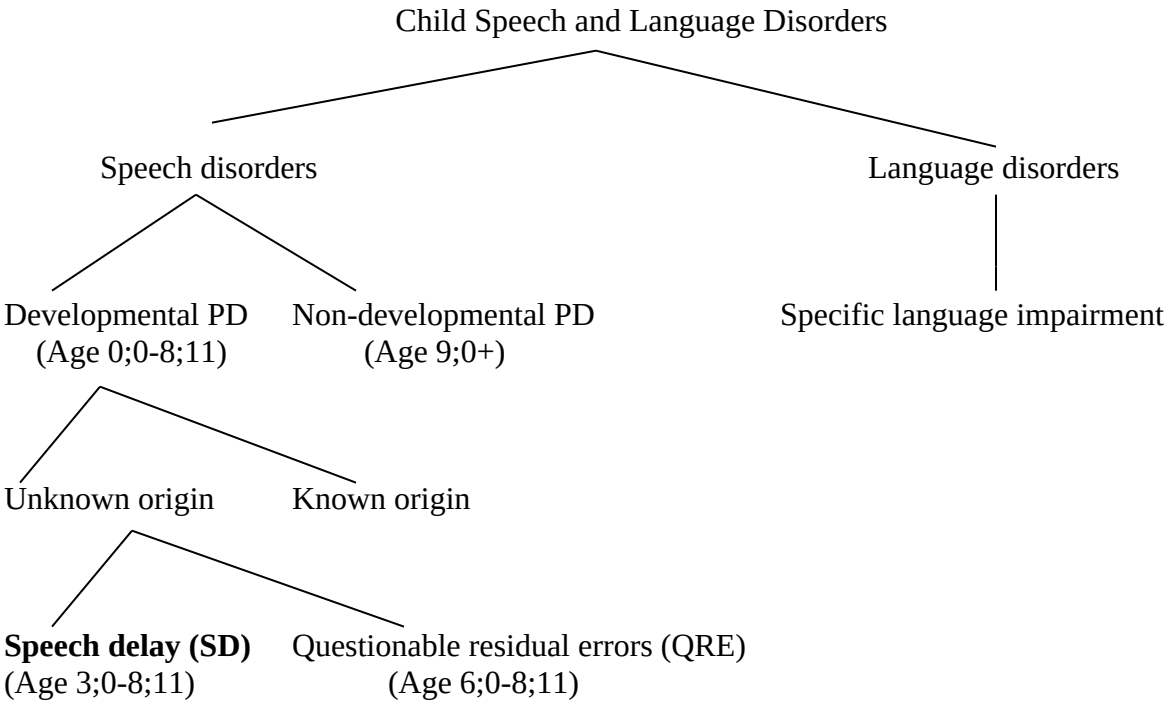
[1] These morphemes have also been argued to have increasing syntactic complexity. For instance it has been suggested that the plural marker is more easily accessible in the grammar than both the possessive and the 3rd p. singular present tense marker (Ritter, 1992; Abney, 1987). See Appendix A for syntactic representations of these morphemes.

Since the paradigm shift of the 1970s, we have changed from describing speech delays in terms of articulatory descriptions to describing them in terms of linguistic analyses (Shriberg et. al., 1999). Although we now regard children with speech delays as having incomplete mental representations for the phonemes of their language, we are still a long ways away from understanding the nature of this problem. There is still a lack of theoretical clarity on the original or persistent causes of speech disorders. Research has considered the role of physiological, cognitive-linguistic and psychosocial deficits in attempt to uncover the root of the problem but there is no clear link. We differentiate speech delays of known origin from those of unknown origin by way of exclusion. If a child does not have a physiological problem, mental retardation or autism then the cause or source of the phonological impairment is classed as unknown.

Phonological disorders are divided into two categories, developmental and non-developmental phonological disorders. If the onset of the disorder is during the developmental period, before the age of nine, then it is deemed developmental whereas if the onset is after the age of nine then it is deemed non-developmental (Shriberg et. al., 1999). Developmental phonological disorders are further sub-classified into two categories: speech delay and questionable residual errors. The former comprises children that have age-inappropriate phoneme deletions and substitutions that affect their intelligibility. The later category is characterized by distortion-type speech errors that do not gravely affect intelligibility. In this study we are concerned with children with developmental speech delays as these children have been shown to often have concurrent language and reading deficits.

Figure 1: An Overview of Relevant Speech and Language Disorder Categories

(Adapted from Shriberg et. al., 1999)



In addition to the challenge of understanding the cause of phonological disorders, there is debate as to whether or not children with PD have a deviant or a delayed system of mental representation. The term phonological disorder implies that there is something underlying atypical about the child's phonological system. Some argue that this is not the case because children with PD appear to have underlying representations that are like those of normally developing children, only they are at a younger stage of development. In other words, children with PD have grammars that are possible in their language.

According to Ingram (1989) children characterized as having a phonological disorder have adult-like underlying representations. He argues that PD children make errors because of natural processes and that their inventories resemble those of normally

developing children. This side of the argument was in part supported by Dinnsen and his colleagues (1990) who conducted a study that looked at the phonetic inventories and phonotactic constraints of forty PD children. They found that PD children do seem to have inventories that are delayed rather than deviant. Thirty-seven out of the forty children observed had non-English phonotactic constraints; however the constraints appeared to be governed by general linguistic principles. Furthermore the children's phonetic inventories corresponded to the Ingram's five levels of phonetic inventory complexity that are observed in normal children. Ingram (1989) posits that normally developing children acquire features in five implicational steps. In the first step they acquire both [sonorant] and [coronal], secondly they acquire [voice], followed by [continuant] in the third step, then the [nasal] feature is acquired fourth, and the last features to be acquired are the [strident] and [lateral] features. Therefore they concluded that these children had delayed rather than deviant systems. Although this data provides fuel for the argument of delayed system rather than deviant systems, it should be noted that a few of the children in this study did not have systems that could be accounted for by general linguistic principles because these children produced unusual errors.

In favour of the deviant system analysis, other studies show that although in many respects PD children do resemble younger normally developing children, they appear to have certain characteristics that are not attributed to normal development. Stoel-Gammon (1991) posits that there are six characteristics of disordered systems that are consistent across the PD population. She describes phonologically disordered children as having a restricted set of speech sounds, limited word and syllable shapes, persistent error patterns, unusual error types, extensive variability, and errors that don't disappear in an age

appropriate manor. These characteristics are evidenced in many studies of preschool children with severe to moderate phonological disorders.

Dinnsen (1999) suggests that PD children differ from normally developing children in their acquisition of voice and manner features. Normally developing children acquire place of articulation contrasts before they acquire voicing contrasts whereas PD children acquire voicing contrasts before they acquire place of articulation. This is supported by a study conducted by Forrest & Morrisette (1999) who showed that preschool-aged PD children maintained accurate voicing most often in production, followed by manner, then place of articulation. Leonard (1995) also argues that PD children have a greater ability to maintain voicing contrasts in addition to other differences. In addition he supports the notion that PD children produce unusual errors and have higher variability in their speech than children with age-appropriate speech.

The body of research to date in phonological disorders provides evidence for both sides of the argument. This suggests that the PD children's phonological knowledge deficit cannot be easily categorized as either a delay or a deficit. It is most probable that these children do not have one single etiology and therefore children assessed with a phonological disorder may or may not have underlying representations that are adult-like. The literature may not agree on the nature of these errors but nevertheless PD children do share some important knowledge deficits and error patterns that need to be better understood.

As we have seen children with PD are not a homogeneous group, but nevertheless children with developmental speech delays do share certain characteristics. PD children have one or more phonological errors that persist past developmental norms and these errors are usually in the form of substitutions or omissions (Dinnsen, 1999). Their sound

system is delayed in that respect; however PD children may also show evidence of a deviant system with non-developmental errors. For example certain substitutions, like producing the stop sound /t/ for the fricative /_/, are developmental. This means that young children acquiring their native language, in this case English, will typically make these errors until they acquire the target sounds. Non-developmental errors however, are errors that children do not usually make while learning the sounds of their language. Some PD children will for example substitute sounds that are usually acquired early like stops, by sounds that are usually developed later such as fricatives. So in this case /b/ may be substituted by /f/ or even /s/. There are many other non-developmental errors that PD children may make which provides evidence that PD children encompass a considerable range of deficits in any of several representational domains (Edwards, Fourakis, Beckman, et al., 1999).

3. Normal Phonological Development

A large body of research provides evidence that the basic features of the normally developing child's phonological system are present by age three (Berko Gleason, 2001). And by the age of four most children are able to produce all of the phonemes of their language (Creaghead et al., 1989). Although we can expect that most children will therefore have acquired the sound system of English by age four, some sounds are more difficult to produce and may not be acquired until a little later. For instance liquids, the fricative /v/ and interdentals are still likely to be in error at age four and a half. Complex consonant clusters may also be acquired later but usually not much later than age five (Berko Gleason, 2001). The phoneme of interest in this study /s/ should be acquired between the ages of 3-3 _ according to Grunwell (1982), but perhaps as late at age eight according to the Sander

(1972) (Creaghead et al., 1989). Children are typically able to produce /s/ as a singleton, as in the word ‘Sue’, before they are able to produce them in consonant clusters as in the word ‘stop’. Importantly though, at age four /s/ may still be substituted by /_/ or /z/ but no longer by a stop. Therefore the phonological process of stopping is age-appropriate only until the age of four.

4. Normal Morphological Development

In the field of morphological development no study is more often cited than Brown’s 1973 longitudinal study of Adam, Eve and Sara (Ingram, 1989). In this study Brown found that although children do not acquire morphemes in exactly the same order, the fourteen grammatical morphemes of English do appear in an implicational order whereby the acquisition of later ranked morphemes implies the acquisition of earlier ones. In a normal system, the acquisition of these ranked grammatical morphemes is correlated with mean length of utterance (MLU) and not necessarily age. The progressive –ing morpheme is acquired first whereas the morphemes of interest in this study, plural, possessive and third person singular present tense are acquired fourth, sixth and tenth respectively. In another well cited study published the same year, deVilliers & deVilliers (1973) reported findings that support Brown’s implicational morpheme rankings. They also supported Brown’s finding that MLU was a better predictor of morphological acquisition than age such that there was a +.92 correlation between percentage of morphemes used and MLU, and only a +.68 correlation with age. According to deVilliers & deVilliers by the age four all of the fourteen grammatical morphemes are produced with at least 90% of the time.

Another renowned study in morphological development is Berko’s pioneering 1958 study, known for it’s often replicated ‘wug test’. In this study, Berko used nonsense words

such as the word ‘wug’, which is the name given to a bird-like creature, to test if children have internalized morphological rules. The plural, possessive and third person singular present tense morphemes each have the same three allomorphs, /-s/ after voiceless obstruents, /-_z/ after sibilants and /-z/ as the basic or underlying allomorph which occurs in all other environments. Regarding these morphemes and their allomorphs, Berko found some interesting gaps in young children’s rules. In their vocabulary children appear to have words that use all three allomorphs; however in the wug test children were not able to generalize the rule of adding /-_z/ after sibilants. For example the children had words like ‘glasses’ in their vocabulary, but they were not able to produce the plural of the word ‘tass’, which would add the /-_z/ morpheme to produce ‘tasses’. So it appears that preschool children have a non-adult rule that the final sibilant already present in the word makes the plural, possessive and third person singular. Interestingly though, children seem to do better at adding /-_z/ for the possessive and third person singular morphemes than they do for the plural morphemes. The most important contribution from this study is that it argues for a systems approach to language learning rather than a storage approach, since in this study the children did not simply memorize the allomorphs of English they showed that they had internalized allomorphy rules, even if at younger ages the rules are not yet adult-like.

A more recent study in the child’s acquisition of morphological morphemes (Lahey, Liebergott, Chesnick et al., 1992) looked at the variability of morphological use by children rather than the similarities found between children. The researchers in this study found that children show a great deal of variability in their acquisition of morphemes but that this variability decreases after a child reaches an MLU of 4.0. Children appear to acquire plurals early since they have them once they reach a MLU of 2.5-2.99, but the third person singular and possessive morphemes are acquired much later. The third person singular morpheme is

acquired once children reach an MLU of 4.5, whereas possessives are not acquired until even later. Compared to Brown's ranking norms this study showed some differences. In this study plurals appeared first instead of 4th, possessives appeared 8th instead of 6th, and the third person singular morpheme appeared 5th instead of 10th, which means that it is actually acquired before possessives which is contrary to Brown's study. According to Lahey and her colleagues the major finding of this study is that there is large variability among children of similar ages or MLUs in the proportional use of grammatical morphemes and in the age and MLU at which the morphemes are acquired. They offer a few possible factors that may account for the variability among phonologically impaired children, such as different learning styles, processing capacities and variability in parental input.

Although these studies do not necessarily agree on a fixed order for morpheme acquisition, they do share some common findings which help us understand how children acquire morphemes. First of all, morphological acquisition as a function of age is noisy and therefore it appears that MLU is a much better predictor of when a child will use a morpheme consistently. Secondly it appears that certain morphemes, like plurals, are acquired earlier than others and that acquiring later morphemes like possessives and the third person singular morpheme implies the acquisition of earlier morphemes. Lastly, before children reach an MLU of about 4.0, morpheme use is highly variable so that a given word may be produced several different ways until the child uses the given morpheme more consistently.

5. Morphological Development of Phonologically Impaired Children

As it was mentioned earlier, compared to the many of studies conducted with respect to the morphological development of normally developing children and children with specific-language impairment, there are relatively few studies that have looked at the morphological development of children with developmental speech delays. In fact the only extensive study to have looked at the morphological development of children with phonological disorders was conducted two decades ago by Paul & Shriberg (1982). In this study Paul and Shriberg investigated whether or not six-year old children with mild-moderate to severely delayed speech also have a morphological delay. In order to do so, they looked at the speech samples of thirty children and observed how they produced the fourteen grammatical morphemes described by Brown (1973). They considered both *morphological production ability* and *overall morphological ability*.

According to Miller (1981) the fourteen grammatical morphemes of English can be divided into two categories based on phonological complexity. Complex morphemes are morphemes which add a consonant like the plural, the possessive and the third person singular present tense morphemes. They are expected to be phonologically simplified in a limited encoding capacity model of speech delay, which posits that when children have to produce marked or complex morphemes there is more demand on their processing capabilities and therefore phonological errors are more likely to occur. An example of a phonological simplification would be if a child produced [_ud] for the word ‘shoes’ or omitted the morpheme altogether. The other category of morphemes, simple morphemes are ones which involve a vowel or consonant change, or add a syllable like the progressive –ing. Simple morphemes are not expected to be simplified because they are less taxing on the child’s processing encoding capacity.

Figure 2: The distinction between complex and simple morphemes

Morphemes	Properties	Examples	Expected to be simplified?
Complex	Add a consonant	Plural *'two cats'* 3rd p. singular *'He walks'*	Yes- taxing on processing abilities
Simple	a) Add a syllable b) Change a V or C	Progressive *'He is walking'* Irregular past *'He came'*	No- not taxing on processing abilities

Therefore given this distinction, a child's ability to produce complex morphemes was considered their morphological production ability. A child's overall morphological ability on the other hand did not have to do with whether or not children simplified morphemes, but rather whether or not they had attained an age-appropriate level of morphological acquisition. Miller assigned the fourteen grammatical morphemes into stages, based on data from deVilliers and deVilliers (1973). The earliest acquired morphemes, like the progressive morpheme, were placed in the first stages whereas the later acquired morphemes, like the third person singular present tense morpheme, were placed in the last stages. A child's overall morphological ability therefore was determined by what stage they had arrived at.

Figure 3: Miller's stage assignment for the grammatical morphemes

(Adapted from Paul & Shriberg, 1982)

Stage	Simple	Examples	Complex	Examples
II	*-ing* *in*	walk*ing* *in* the box	**plural**	two dog*s*
III	*on*	*on* the table	**possessive**	daddy*'s* chair
V	irregular past	*saw*	regular past	walk*ed*

	articles	*a, the*		
V+	irregular 3rd p. singular	she *does*	**regular 3rd p. singular**	he go*es*

In considering both morphological production and morphological ability (or stage), Paul and Shriberg determined that there were four possible patterns that the PD children could show in their morphological development. They could have a first pattern of attaining an age-appropriate stage and not simplifying complex morphemes and therefore their errors would simply be productive phonological errors. An example of this would be a PD child that has acquired the 3rd person singular morpheme (eg. He walks), which is a later acquired morpheme developmentally and it is also a complex morpheme. This morpheme however might be produced with a substitution, [hi w_k_], so that the error with the target morpheme is a productive phonology error and not a morphological error. PD children could also pattern in a second manner, whereby they do not simplify complex morphemes but they are at a delayed stage of morphological attainment. For example a child could be able to produce the earlier acquired plural morpheme, which is complex, but they never produce utterances with possessives or the third person singular which are age-appropriate but acquired later than plurals. In this case this morphological delay could be considered a general morphological delay since the child is delayed in their overall morphological ability. The last two patterns of morphological development support the limited capacity model (Panagos, Quine & Klich, 1979) because children that pattern in this way have difficulties producing complex morphemes and therefore simplify their production of these morphemes. If children pattern in the third way, then they attain the age-appropriate stage but they cannot produce complex morphemes. In this case children would be able to produce all of the morphemes in the later stages except those that are complex. For example a child could produce the contractible auxiliary *be*, as in 'he is walking', which is a simple

morpheme acquired in the last stage, but not the third person singular morpheme, as in 'he walks', which is a complex morpheme in the same stage. These children would therefore be delayed in morphological production but not overall ability. The last pattern involves children who are delayed in both morphological production and overall morphological ability. For example a child that fits this pattern would only produce the simple morphemes in the earlier acquired stages, like the progressive *-ing*.

Figure 4: Morphological development in PD children: Four possible patterns

	Reached an age-appropriate stage	Did not reach an age-appropriate stage
Produce complex morphemes	*Errors are due to productive phonology* eg. Two shoes [tu _ud] He walks [hi w_k_][2]	*Errors due to general delay* eg. Two shoes [tu _ud] He __ walking[3].
Do not produce complex morphemes	*Errors due to limited encoding capacity* eg. He is walking[4] He walks [hi w_k]	*Errors due to limited encoding capacity* eg. Two shoes [tu _u][5] He walks [hi w_k]

The findings of this study were quite striking since Paul and Shriberg found that two-thirds of the children had delayed overall morphological ability, in that they did not reach an age appropriate stage of morphological acquisition. Furthermore, 86% of the children appeared to have some kind of morphological delay; delayed overall morphological ability, delayed morphological production, or both. This means that only

[2] Regular 3rd person singular morpheme is a late acquired complex morpheme. In this pattern children do produce this complex morpheme.
[3] Contractible auxiliary be 'is' is late acquired simple morpheme. In this pattern children have not reached stage V+, so do not produce morphemes at this stage, even simple ones.
[4] Contractible auxiliary be 'is' and 3rd p. sing are stage V+. In this pattern children will only be able to produce the simple morpheme.
[5] In this pattern children do not produce complex morphemes even on earlier acquired morphemes like plurals.

14% or four of the thirty PD children did not have a morphological deficit in addition to their phonological impairment.

This research study posits that most children with a developmental phonological disorder also have a morphological deficit. It is a preliminary step towards determining whether or not children with phonological disorders have impairments in other aspects of language, like morphology. It is also another step towards understanding the nature of phonological disorders. Leonard (1995) suggests that perhaps PD impedes development in other areas of language. For example English children who fail to acquire [s] and [z] in word-final position are at a disadvantage for acquiring plurals, possessive and the third person singular present tense morpheme. At this stage much more research is needed before any conclusions can be drawn as to whether or not PD children really do have other language deficits. Furthermore, if more research supports the preliminary finding that children with PD also have other language deficits, we will then have to focus our attention to determining the nature of these problems.

In Paul and Shriberg's study the participants were six-year-old children with a mild-moderate to severe phonological disorder. Since it was the first study of its kind, they were mostly interested in describing the morphological abilities of these children, so they did not investigate possible causes or reasons for the morphological delays they found in the children. Therefore in the present study we hope to extend Paul and Shriberg's findings by looking at a younger and more severe group of phonologically disordered children. Additionally we would like to extend these findings by investigating some possible reasons for the PD children's morphological deficits. Research shows articulation learning is closely tied to the child's underlying knowledge of language-specific speech sound contrasts. This in turn is derived from the child's perceptual ability to accurately segment

words into individual phonemes and discover the acoustic cues that differentiate one phoneme from another (Rvachew & Jamieson, 1995). It has been suggested that some children with PD have difficulty differentiating phonemes (Bird et. al. 1995; Rvachew & Jamieson, 1989.) and this may be one underlying reason that PD children have difficulty representing speech sounds. Therefore the present study will investigate the role of phonological perception as well as receptive morphological knowledge on productive morphology.

6. Method

6.1 Participants

Group 1: The comparison group was comprised of 5 four-year old monolingual English speaking children recruited through the Alberta Children's Hospital in Calgary, Alberta. Two of the children were girls and three were boys (Mean age: 4;8). Before experimental testing began, these children were assessed with the Goldman-Fristoe Test of Articulation-2nd edition (GFTA-2) to determine their productive speech ability, and the Peabody Picture Vocabulary Test-Revised to determine their level of receptive vocabulary. The criteria for acceptance into the comparison group was a score above the 25th percentile on GFTA-2 and a score above a standard score of 86 on the PPVT-R. These children scored in the range of 58th to 98th percentile (Mean: 78th percentile) on the GFTA-2 and they scored within normal limits on the Peabody Picture Vocabulary Test with a standard score range of 107 to 124 (Mean: 119.20). Therefore these children were assessed as having age-appropriate speech productions and age-appropriate receptive vocabulary.

Table 1a: Comparison group gender, age, GFTA-2 and PPVT-R scores

Subject #	Gender	Age (months)	GFTA-2 percentile	PPVT-R standard score
1	M	55	58	123
3	M	58	90	123
5	M	51	98	124
7	F	58	60	119
9	F	58	84	107
	Average	**56.00**	**78.00**	**119.20**

Group 2: The speech-delayed group was comprised 5 four-year old monolingual English speaking children that were also recruited through the Alberta Children's Hospital in Calgary, Alberta. Three of the children were girls and two were boys (Mean age: 4;10). The children were referred to the investigator by their treating Speech-Language Pathologist after they met the following criteria. The children had to have scored severe to moderate on their most recent test of articulation (GFTA-2 or SPAT-D[6]), and they had to have age-appropriate receptive morphology.

Four of these five participants scored below the 1st percentile on the GFTA-2 or SPAT-D, and the other participant got a score of 6th percentile (Mean: 2nd percentile). All of these participants scored within normal limits on the PPVT-R with a standard score range of 87 to 138 (Mean: 109.20).

Table 1b: Delayed group gender, age, GFTA-2 and PPVT-R scores

Subject #	Gender	Age (months)	GFTA-2 percentile	PPVT-R standard score
2	M	56	6	87
6	M	53	0.5	98
8	F	61	0.5	138

[6] SPAT-D (Structured Photographic Articulation Test)

10	F	61	0.5	124
11	F	58	0.5	99
	Average	**57.80**	**1.60**	**109.20**

6.2 Procedure

Before testing the investigator explained the three tasks involved in the experiment to the parent and child and had the parent read and sign a consent form. A copy of the consent form was given to the parent. The investigator then informed the parent that a copy of the results of their child's test scores would be given to them at the end of their participation in the experiment. In the case of the speech-delayed group the investigator asked the parent if they would also want a copy of the results given to their treating Speech-Language Pathologist. The three tasks involved in the experiment were a phonemic perception test, a receptive morphology test and picture book retell task.

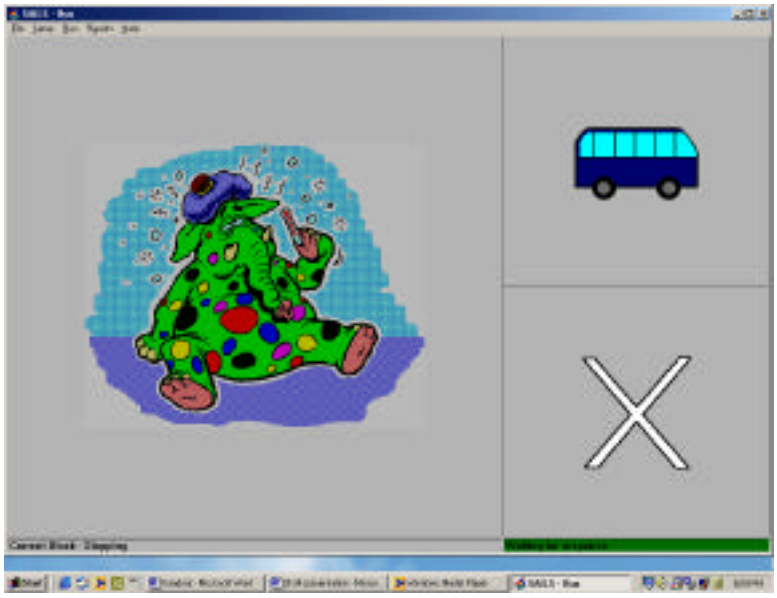
6.2.1 Phonemic Perception Test

The phonemic perception test was a computer-based assessment tool called SAILS. The SAILS program targeted misarticulated /s/ in word initial and word final position, in singleton and cluster contexts. Each child listened to some words presented over headphones, and then indicated to the investigator whether the word was produced correctly or incorrectly.

The instructions given to the child were: "You will hear some people trying to say the word _____. Sometimes the person will say _____ correctly. Sometimes the person will make a mistake and say the word _____ wrong. When you hear the word _____ point to the picture of the _____. If the person doesn't say the right word point to the X. If the person says the word wrong point to the X."

After the child responded that the word was produce correctly or incorrectly, the computer produced cartoon pictures for the child as a reward for listening and responding to the words. The words that the child listened to were ‘Sue’[su], ‘bus’[bʌs], ‘stop’[st_p], ‘paste’[pejst], and ‘fox’[f_ks]. In figure 5 we see an example of the SAILS module ‘bus’. A participant would point to the picture of the bus in the top right corner if he or she thought the word ‘bus’ was said correctly, or to the big X below the picture of the bus if he or she though the word was said incorrectly. The cartoon elephant on the right on the screen is a reward picture that tells the child when he has completed the module. In this case the child has completed the module when the elephant is all better.

Figure 5: Example of a SAILS module: ‘Bus’



The tokens used for each module were recorded from human adult and child participants. Each module consisted of five correct exemplars and five incorrect exemplars presented in a randomized manner. The incorrect exemplars included substitutions, distortions, and consonant cluster reductions. For example in one module the child hears

five correct productions of the word ‘bus’ [bʌs], and five incorrect productions of the same word, such as [bʌt], [bʌ_], [bʌts], or [bʌ_]. The entire phonemic perception task involved two practice modules and eight experimental modules. The practice modules were used to familiarize the child with the task. The children were given feedback during the practice blocks as to how he or she was doing, but they were given no help during the eight experimental blocks. Each child reached the 80% criterion on the practice blocks before they moved onto the experimental blocks. This activity lasted approximately 15 to 20 minutes.

6.2.2 Receptive Morphology Test

Each child’s receptive morphological knowledge was assessed using the grammatical morphemes subtest of the Test of Auditory Comprehension of Language-3rd edition (TACL-III). This is a standardized test used by Speech-Language Pathologists in assessing children’s receptive morphology knowledge. The test is a picture pointing task that involves listening to a sentence and then choosing which of three pictures corresponds to the sentence. The subtest had forty-six items which investigated children’s perception of grammatical morphemes which include the targeted morphemes: plurals, possessives, 3rd person singular present tense, as well as others. For example a child would hear a sentence like, ‘The boys ran’, and he would point to the picture that he thinks goes with that sentence. The three picture options are: one boy running, three boys running, and one boy sitting. This activity also lasted approximately 15 to 20 minutes.

6.2.3 Speech Production Task

The last task assessed each child's productive phonology and morphology skills through an elicited language sample. The investigator presented three picture books to each child.

1) Kubler, A. 1999. The babysitter. Sydney: Child's Play International

2) Savary, S. 2000. Cailou: One or Many. China: Editions Chouette.

3) Kubler, A. 1999. Man's Work. Sydney: Child's Play International

Each book was selected to elicit the production of the targeted morphemes. First the investigator told the child that she would tell them the story and they had to listen carefully because afterwards it would be their turn to tell the story back to her. The same procedure was used for all three of the books and if the child failed to produce enough token morphemes, the investigator asked the child some questions about the pictures in the book to elicit the production of these morphemes. Each speech sample was recorded using a Sony Digital Audio Tape (DAT) recorder and a small microphone that clipped onto the child's clothing.

6.3 Data coding

6.3.1 SAILS Phonemic Perception Test

The SAILS computer program gives a percentage of correct responses for each module that the child completes. The criterion for good phonemic perception was set at 80%. The investigator recorded the child's percentage scores for the eight practice modules and they were averaged the scores to see if there was a significant overall difference on phonemic perception performance between the two groups.

6.3.2 TACL-III Grammatical Morphemes Subtest

The TACL-III grammatical morphemes subtest grades a response as being either right (1 point) or wrong (0 point). There are forty-six items in the test so a child gets a raw score out of 46, which is then converted into a percentile. The criterion for average receptive morphology skills was set at the 50^{th} percentile. Normative data shows that children aged 4;0 to 4;5 have a mean raw score of 18.86, children aged 4;6 to 4;11 have a mean raw score of 20.46, and children aged 5;0 to 5;5 have a mean raw score of 25.11 on the grammatical morphemes subtest. The investigator recorded the child's percentile scores and averaged the scores to see if there was a significant overall difference on receptive morphology between the two groups.

6.3.3 Story Retell Task

Each child's speech sample was transcribed with traditional orthography, and phonetically with IPA. From these transcribed speech samples the mean length of utterance (MLU) and the percentage of consonants correct (PCC) was calculated. The PCC score is a measure that gives additional information about a child's level of intelligibility (Shriberg, Lewis, McSweeny et al., 1997). Every correct production of a consonant is coded as one point while every incorrectly produced consonant is coded as zero points. The PCC score is calculated as:

$$PCC = \left[\frac{\text{Number of correct consonant productions}}{\text{Number of total consonant productions}} \right] \times 100$$

A child that has a PCC score below 50% has very low intelligibility and therefore his errors are severe, while a child that has a score of 50-65% is still quite difficult to understand so his errors are moderate to severe, a score of 65-85% means that a child's errors are mild-moderate, and lastly a score of 90% and above means that a child is easily understood and his errors are considered mild.

From these transcriptions the investigator also calculated the number obligatory contexts for each of the three target morphemes. An obligatory context is where a morpheme is needed in order for the utterance to be grammatical. For example the utterance, "More shoes are in the closet" requires a plural morpheme on the word 'shoe' otherwise the utterance would be ungrammatical. For each of the obligatory contexts a morpheme was marked as being *correct* if the correct allomorph was produced. For example a correct production of the plural in the word 'shoes' would be [_u**z**]. A morpheme was said to be *omitted* if no morpheme was present. For example 'shoes' would be produced as [_u]. A *substitution* was produced if the morpheme was produced with a substituted sound, such as the word 'shoes' could be produced as [_ud]. A morpheme was produced as a *pronunciation error* if the morpheme was produced as a distorted sound such as a lateralized or dentalized /s, z/. Lastly a morpheme *addition* is when a morpheme was present in a non-obligatory context. For example in the utterance, "Caillou has a crayon", it would be ungrammatical to add a plural morpheme to the word 'crayon'. The criterion for saying that a child had acquired the morpheme was set for 90% production of the morpheme in obligatory contexts. This includes producing the morpheme correctly, with a substituted sound or with a pronunciation error. In other words if the morpheme is omitted more than 10% of the time then the child has not yet acquired that morpheme.

7. Results

7.1 Phonemic perception test

Table 2 shows each participant's average score on the SAILS phonemic perception test. The percentage scores shown in the table were calculated by averaging each participant's scores on the eight /s/ modules. To determine if there is a significant difference between the two groups on this task the investigator used the Mann-Whitney U non-parametric rank test[7]. This test involves assigning a rank to each participant's score and then averaging these scores for each group to get the mean rank score. These mean rank scores are then compared to see if they are significantly different. The p-value for these tests was set at 5%, therefore the difference was said to be significant if $p < 0.05$.

Table 2: Average SAILS scores for both groups

Comparison Group		Delayed Group		
Subject #	Percent correct	Subject #	Percent correct	
1	85.00	2	52.50	
3	71.25	6	58.75	
5	81.25	8	91.25	
7	81.25	10	87.50	
9	75.00	11	78.75	
Average	**78.75**	**Average**	**73.75**	
Mean rank	5.60	Mean rank	5.20	***p > 0.05***

From this table we can see that the comparison group had an average performance of 78.75% on these modules whereas the delayed group had an average performance of 73.75%. The Mann-Whitney U test determined that the group scores on the phonemic perception of /s/ are not a significantly different (group 1: mean rank 5.60, group 2: mean rank 5.20, $p < 0.05$).

[7] This test was calculated by hand for the SAILS scores and the TACL-III scores, but with SPSS software for all the other comparisons.

Interestingly, both groups scored slightly below the 80% criterion for good phonemic perception that was set prior to testing[8]. Although the differences between the groups were not found to be significant, there are still some interesting descriptive differences between the groups. The children in the comparison group have a range of scores from 71.25% to 85.00%, whereas the children in the delayed group have a range of scores from 52.50% to 91.25%. Therefore it is apparent that the children in the delayed group have a much larger range of scores.

In the comparison group it was not expected that any of the children would do worse than the 80% criterion but two of the children in this group, participant 3 and participant 9, got scores of 71.25% and 75% respectively. It is difficult to assess whether or not these scores indicate poorer than 'age-appropriate' perception or not. However when we compare these scores to the children in the delayed group we find that two of the children in the delayed group, participant 2 and participant 6, received far lower scores than any of the other eight participants with scores of 52.50% and 58.75% respectively. Therefore although three out of the five children in the delayed group do not appear to have a phonemic perception problem, the other two children in this group appear to have difficulties accurately perceiving the phoneme /s/[9].

This descriptive data may indicate that children with phonological disorders vary in their phonemic perception abilities, with some children having good or average phonemic

[8] The reason both groups performed worse than the 80% criterion overall, may be due to the difficulty of some of the modules. All of the children appeared to have difficulty with the BUS 2, SUE 2, and SUE 3 modules, which lowered their overall scores. After testing adults with the same modules, it was found that adults often performed at less than criterion on these modules as well. If these problematic modules are not considered in the participants' averaged scores than the comparison group has an average score of 87.20% on the remaining five modules, and the delayed group has an average score of 78.80% on the same five modules. This difference was also found to be insignificant ($p > 0.05$).

[9] In fact two of the participants 8 and 10, who are identical twins performed better on this task than all the other participants in this study.

perception and others having poor perception. However it must be kept in mind that this study has a small sample size therefore it is difficult to generalize these findings.

7.2 Receptive Morphology Test

Table 3 below shows each participant's average score on the grammatical morphemes subtest of the TACL-III. The raw scores shown in the table are the number of correct responses out of 46. These raw scores were then converted into percentile scores, which were used to determine statistical significance. An average score on the grammatical morphemes subtest is reaching 50th percentile. As we mentioned earlier on page 26, normative data shows that children aged 4;0 to 4;5 have a mean raw score of 18.86, children aged 4;6 to 4;11 have a mean raw score of 20.46, and children aged 5;0 to 5;5 have a mean raw score of 25.11 on the grammatical morphemes subtest.

Table 3: TACL-III Grammatical morphemes subtest results for both groups

Comparison Group			Delayed Group			
Subject #	Raw score	Percentile	Subject #	Raw Score	Percentile	
1	36	98	2	31	95	
3	26	84	6	23	84	
5	31	95	8	36	95	
7	28	91	10	33	95	
9	23	75	11	28	91	
Average	**28.80**	**88.60**	**Average**	**30.20**	**92.00**	
	Mean rank	5.10		Mean rank	5.90	***p > 0.05***

Both groups of children did very well on the TACL-III subtest. In fact all of the ten children received a score that was above average. The comparison group got an average percentile score of 88.60 while the delayed group got an average percentile score of 92.00, which were not found to significantly different scores (Comparison group: Mean rank 5.10,

Delayed group: Mean rank 5.90, $p > 0.05$). Therefore it appears that the children in neither of the groups have a receptive morphological deficit.

7.3 Story Retell Task

Now we take a look at the productive abilities of both groups of children. The speech sample for each child was recorded while he or she talked about the three storybooks that were mentioned earlier. After orthographically and phonetically transcribing the speech samples, the percent of consonants correct (PCC) and the Mean Length of Utterance (MLU) for each child was calculated.

7.3.1 Percent Consonants Correct (PCC) Scores

In addition to the GFTA-2 the PCC score gives further information about a child's intelligibility. As we mentioned earlier on page 26, a score of 90% or above means a child produces errors that only mildly affect his intelligibility, a score of 65-85% means that his errors are mild-moderate,

Table 4: Percent of consonant correct (PCC) scores for both groups

Comparison Group		Delayed Group	
Subject #	PCC	Subject #	PCC
1	82.57	2	56.37
3	96.84	6	59.58
5	97.31	8	41.99
7	97.71	10	33.73
9	99.07	11	59.13
Average	**94.70**	**Average**	**50.16**

The comparison group children had an average PCC score of 94.70%. Four of these children had scores above 90% so their errors or intelligibility difficulties were 'mild',

whereas participant 1 had a PCC score of 82.57% and therefore his intelligibility difficulties were ‘mild-moderate’. This particular child had distorted /s/ productions which affected his PCC score but did not severely impair his intelligibility.

Contrastively, the delayed group of children had an average PCC score of 50.16%. Two of these children, participants 8 and 10, had PCC scores below 50% and therefore their intelligibility difficulties were ‘severe’, whereas the other three children had PCC scores below 60% and therefore their intelligibility difficulties were ‘moderate-severe’. These children were very difficult to understand during conversation because they substituted and omitted a wide range of speech sounds.

7.3.2 Mean Length of Utterance (MLU)

Next we take a look at the children’s MLU scores because it has been shown in the literature that after a child reaches an MLU of 4.0 they normally have acquired all of the 14 grammatical morphemes of English (Brown, 1973; deVilliers & deVillers, 1973). Table 5 shows the MLU scores for all of the participants.

Table 5: Mean length of utterance (MLU) scores for both groups

Comparison Group		Delayed Group	
Subject #	MLU	Subject #	MLU
1	4.72	2	2.58
3	5.12	6	4.94
5	4.80	8	3.72
7	5.78	10	4.84
9	4.66	11	4.58
Average	**5.02**	**Average**	**4.13**

The children in the comparison group had an average MLU score of 5.02. All of these children had an MLU above 4.0 and therefore we should expect that they have

acquired all of the fourteen grammatical morphemes of English, including the three targeted morphemes plural, possessive and 3rd p. singular. The delayed group had an average MLU score of 4.13, with only two of these children having MLU scores below 4.0. Participant #2 had an MLU score of 2.58 therefore we may expect from his MLU that he would not yet have acquired the later acquired morphemes like 3rd p. singular. Participant #5 had an MLU of 3.72 which is not significantly below 4.0 therefore it is difficult to predict from this MLU score if he would have yet acquired the 3rd p. singular morpheme. Therefore given their MLU scores, except for participant #2, we should predict that all of these children have acquired the target morphemes if they do not have a morphological deficit.

7.3.2 Plural Morpheme Production

Next we turn to the comparison group and the delayed group's morphological productions during the story retell task. We start with the plural morpheme which is predicted to be acquired early during age-appropriate language development. Table 6a shows the plural productions for the comparison group. The first column, 'obligatory context', shows how many times during production the plural morpheme should have been produced. For example if the utterance was, "She has a lot of toys", the context of this sentence requires the plural morpheme as "She has a lot of toy" would be ungrammatical. The other five columns to right show how the child produced the obligatory morpheme. We expected that the comparison group would reach the 90% production criterion for this morpheme.

Table 6a: Comparison group's plural productions

Subject #	Obligatory Context	Correct	Omission	Addition	Pronunciation error	Substitution
1	27	3	1	0	23	0
3	37	35	2	0	0	0
5	28	24	0	0	2	2
7	25	24	1	0	0	0
9	17	17	0	0	0	0
Total	134	103	4	0	25	2
	Percentage	**76.87%**	**2.99%**	**0.00%**	**18.66%**	**1.49%**

As we can see in the table, the comparison group children have acquired the plural morpheme. They only omitted the morpheme 2.99% of the time, which is only four times out of a possible 134 times. Therefore if we total all of the production types except omissions we get the percentage that the plural morpheme was actually produced. In the comparison group the children produced the plural morpheme 97.01% of the time, where 76.87% of the total productions were accurately produced such as 'bananas' produced as [b_næn_z], 18.66% were produced as a distorted sound such as [b_næn_z^{l}] (where [z^{l}] is a lateralized [z]), and only 1.49% of the plural productions were substituted such as [b_næn_d]. The reason that the pronunciation errors were so high in this group is because participant 1 produced /s, z/ as a lateralized sounds. Importantly though all of the children in the comparison group achieved the 90% criterion for plural production.

In table 6b we look at the plural morpheme productions of the delayed group. If the children in this group do not have a morphological deficit then we should expect them to perform as well as the comparison group. However we predicted that these children will not reach an age-appropriate morpheme acquisition stage and therefore we expect that these children will not reach the 90% criterion of production.

Table 6b: Delayed group's plural productions

Subject #	Obligatory	Correct	Omission	Addition	Pronunciation	Substitution

	Context				error	
2	9	7	0	0	0	2
6	21	4	3	1	0	13
8	19	6	6	0	4	3
10	22	0	14	0	1	7
11	16	15	1	0	0	0
Total	87	32	24	1	5	25
	Percentage	**36.78%**	**27.59%**	**1.15%**	**5.75%**	**28.74%**

According to this data the delayed group did not fully acquire the plural morpheme. The children omitted this morpheme 27.59%, which is greater than the 10% criterion that is expected in the age-appropriate population. An example of this would be producing the word ‘bananas’ [b_næn_z] without any plural marker such as participant 10 [dinæn_]. Furthermore when the children did produce the morpheme they did so with less phonetic accuracy than the comparison group. For instance the plural morpheme was produced correctly only 36.78% of the time, and it was substituted by another sound 28.74% of the time, for example participant 6 produced ‘crayons’ [k_ej_nz] as [kwej_nd]. However when we look closer at the data we find that two of the children in this group, participants 2 and 11, reached the 90% production criterion. Participant 2 never omitted the morpheme and participant 11 omitted the morpheme only once in sixteen obligatory contexts. Therefore it appears that these two delayed children have acquired the early acquired (stage II) plural morpheme. The other three children in this group have not yet acquired this morpheme, though participants 6 and 8 look as though they are on their way to acquiring plurals. Participant 10 however omits plurals 63.64% of the time and therefore it appears that she is quite delayed since plurals are acquired quite early developmentally.

Table 6c shows a comparison between the two groups in their production of the plural marker. Due to a small sample size we again used the Mann-Whitney U non-

parametric rank test to calculate whether or not the differences between the group productions are significant.

Table 6c: A comparison between groups on plural marker productions

Possible production of the morpheme	Group	Mean Rank	Mann-Whitney U	*p-value*
Correct	Comparison	7.00	5.000	0.117
	Delayed	4.00		
Omitted	Comparison	3.80	4.000	0.072
	Delayed	7.20		
Addition	Comparison	5.00	10.000	0.317
	Delayed	6.00		
Pronunciation error	Comparison	5.70	11.500	0.814
	Delayed	5.30		
Substitution	Comparison	3.60	3.000	0.034
	Delayed	7.40		

According to the Mann-Whitney U test there was no significant difference between the groups in the correct production (U = 5.000, p = 0.117) or the omitted production (U = 4.000, p = .072) of the plural morpheme. The only significant difference that was found between the groups for the plural morpheme was with the substitution production (U = 3.000, p = 0.034). It appears that the delayed group substitutes the plural allomorphs for another sound significantly more often than the comparison group. For example the delayed group was more likely to make a substitution error like producing the word ‘crayons’

[k_ejanz] as [k_ejand]. We must keep in mind though that although the differences between groups for correct production and omitted production were not found to be significant, there was still a 40% difference between the groups in the correct production and a 24% difference in the omission of the plural morpheme[10]. Therefore according to this data most of the children in the delayed group are not in the age-appropriate range for plural production since they simplify this morpheme more often than the comparison group.

7.3.4 Possessive Morpheme Production

Next we turn to the production of the possessive marker. The possessive marker has been shown in the literature to be acquired a little later than plural morpheme, and according to Miller's stage assignment it is a stage III morpheme. We should still expect that the comparison group will have acquired this morpheme since they have all reached an MLU 4.0. Table 7a shows the comparison group's productions of the possessive marker in obligatory contexts.

Table 7a: Comparison group's possessive marker productions

Subject #	Obligatory Context	Correct	Omission	Addition	Pronunciation error	Substitution
1	14	1	2	1	10	0
3	8	7	0	0	1	0
5	8	8	0	0	0	0
7	10	10	0	0	0	0
9	6	6	0	0	0	0
Total	46	32	2	1	11	0
	Percentage	**69.57%**	**4.35%**	**2.17%**	**23.91%**	**0.00%**

[10] This study has a very small sample size which means it has low statistical power. Given a larger sample size we may have found that these differences are indeed significant because the differences between the groups do appear descriptively important.

This table shows that the children in the comparison group have indeed acquired the possessive morpheme. They only omitted the morpheme 4.35% of the time and the majority of their productions were accurate (69.57%). Again we see that the pronunciation errors were mostly due to participant 1, who has lateralized /s, z/ productions. When we add all of the production possibilities together, except omission, we see that the children in this group produced the possessive marker in 95.65% of the obligatory contexts and therefore we can assume that they have acquired this morpheme.

Table 7b shows the delayed group's production of the possessive marker. We expect that this morpheme will be omitted more often from obligatory contexts compared to the plural morpheme because it is acquired later developmentally.

Table 7b: Delayed group's possessive marker productions

Subject #	Obligatory Context	Correct	Omission	Addition	Pronunciation error	Substitution
2	1	1	0	0	0	0
6	6	0	1	0	0	5
8	13	2	9	0	0	2
10	9	0	9	0	0	0
11	6	3	3	0	0	0
Total	35	6	22	0	0	7
	Percentage	**17.14%**	**62.86%**	**0.00%**	**0.00%**	**20.00%**

We see in table 7b that the delayed group have not acquired the possessive marker. They omitted the morpheme from obligatory contexts 62.86% of the time, which is substantially higher than the 10% criterion for acquisition. The children only produced the morpheme correctly 17.14% of the time, while they substituted the correct allomorph with another sound 20.00% of the time. It appears that only two of these children, participants 2[11] and 6, acquired the possessive morpheme. The other three children omitted the

[11] There was only one obligatory context whereby participant 2 could produce the possessive morpheme so it is difficult to assess whether or not he actually has acquired this morpheme.

possessive morpheme 50% to 100% of the time. Therefore it appears that overall the children in this group have not yet acquired the possessive marker.

Table 7c shows a comparison between the two groups on their production of the possessive marker. Again we used a non-parametric rank test to assess whether the differences between the groups are significant.

Table 7c: A comparison between groups on possessive marker productions

Possible production of the morpheme	Group	Mean Rank	Mann-Whitney U	*p-value*
Correct	Comparison	6.90	5.500	0.130
	Delayed	4.10		
Omitted	Comparison	3.60	3.000	0.034
	Delayed	7.40		
Addition	Comparison	6.00	10.000	0.317
	Delayed	5.00		
Pronunciation error	Comparison	6.50	7.500	0.136
	Delayed	4.50		
Substitution	Comparison	4.50	7.500	0.136
	Delayed	6.50		

The table shows that there was not a significant difference between the groups in the correct production of the possessive morpheme ($U = 5.500$, $p = 0.130$). However a significant difference was found in the omission of this morpheme ($U = 3.000$, $p = 0.034$). It appears that the children in the delayed group omit the possessive morpheme

significantly more often than do the children in the comparison group and therefore they are not in the age-appropriate range for production of this morpheme.

7.3.5 Third person Singular Present Tense Morpheme Production

The last morpheme of interest in this study is the 3rd person singular present tense marker. This morpheme has been shown to be acquired late developmentally such that it is a stage V+ morpheme by Miller's stage assignment. Table 8a shows the comparison group's productions of the 3rd person singular present tense marker in obligatory contexts. Once again we expect that these children will have acquired this morpheme.

Table 8a: Comparison group's 3rd p. singular marker productions

Subject #	Obligatory Context	Correct	Omission	Addition	Pronunciation error	Substitution
1	10	2	3	0	5	0
3	8	8	0	0	0	0
5	13	12	1	0	0	0
7	8	7	1	0	0	0
9	10	10	0	0	0	0
Total	49	39	5	0	5	0
	Percentage	**79.60%**	**10.20%**	**0.00%**	**10.20%**	**0.00%**

The children in this group appear to have acquired the 3rd person singular present tense marker since they omit it only 10.20% of the time. They produce it correctly 79.60% of the time and the only other errors in their productions are the pronunciation errors produced by participant 1. All of the children in this group, except for participant 1, reached the 90% criterion for production therefore we can assume that the children in this group have acquired the late acquired 3rd person singular present tense marker.

Now we turn to table 8b which takes a look at the 3rd person singular present tense marker productions in the delayed group. Again we hypothesized that the children in this group have a morphological deficit and therefore will not reach the 90% criterion for morpheme production. Given that the 3rd person singular present tense marker is later acquired than the previous two morphemes we also expect that they will omit this morpheme more often than both the plural and possessive morpheme.

Table 8b: Delayed group's 3rd p. singular marker productions

Subject #	Obligatory Context	Correct	Omission	Addition	Pronunciation error	Substitution
2	5	0	5	0	0	0
6	13	0	13	0	0	0
8	13	0	12	0	0	1
10	18	0	18	0	0	0
11	6	5	1	0	0	0
Total	55	5	49	0	0	1
	Percentage	**9.09%**	**89.09%**	**0.00%**	**0.00%**	**1.82%**

Given the data shown in table 8b we see that the children in this group have clearly not yet acquired the 3rd person singular present tense marker. They omit this morpheme 89.09% of the time and only produce it correctly 9.09% of the time. Three of the children, participants 2, 6, and 10 never produced the morpheme in an obligatory context and one child, participant 8 omitted the morpheme 92.31% of the time. Only one of the five children in this group, participant 11, appeared to have acquired this morpheme since she only

omitted it one time in six obligatory contexts. Therefore it appears that the delayed children have difficulties producing the late acquired 3rd person singular present tense marker more so than the other two morphemes.

Table 8c compares the productions of the 3rd person singular present tense marker between the two groups to see whether the groups differ significantly.

Table 8c: A comparison between groups on 3rd p. singular marker productions

Possible production	Group	Mean Rank	Mann-Whitney U	*p-value*
Correct	Comparison	7.80	1.000	0.013
	Delayed	3.20		
Omitted	Comparison	3.20	1.000	0.015
	Delayed	7.80		
Addition	Comparison	5.50	12.500	1.000
	Delayed	5.50		
Pronunciation error	Comparison	6.00	10.000	0.317
	Delayed	5.00		
Substitution	Comparison	5.00	10.000	0.317
	Delayed	6.00		

According to the Mann-Whitney U test the two groups of children differ significantly in their correct productions (U = 1.000, p = 0.013) and their omissions (U = 1.000, p = 0.015) of the 3rd person singular present tense marker. The children in the delayed grouped produced fewer correct productions of this morpheme, and omitted it

significantly more often than the children in the comparison group. Therefore once again the delayed children were not in the age-appropriate range for morpheme production.

7.3.6 Comparison of the Three Morphemes

Lastly, since it appeared that the children made more production errors as the morphemes increased in syntactic complexity[12] it is of interest to take a look at the three target morphemes in this study to see if there are significant differences between the productions of each. In other words, we are interested in seeing if these morphemes differ significantly in their level of difficulty. To determine if these morphemes are themselves significantly different we used the Wilcoxon repeated measures non-parametric test. All of the 10 participants in this study were used in this analysis because we were interested to see if these morphemes differed in difficulty for all of children[13]. Table 9 shows a comparison between the three morphemes in how the children in both groups correctly produced these morphemes.

Table 9: A comparison of percent correct productions for all participants

Morphemes	N	Mean	Minimum	Maximum	Mean Rank	
Plural	10	60.99	0.00	100.00	2.20	
Possessive	10	56.00	0.00	100.00	1.95	*p- value*
3rd. p. sing	10	48.31	0.00	100.00	1.85	0.657

We see in this table that the children in this study did not appear to significantly produce some morphemes with more accuracy than others ($p = 0.657$). This means that the children produced the three morphemes with roughly the same level of phonetic accuracy.

[12] Recall that the 3rd p. singular morpheme is the most structurally complex morpheme of the three. The plural morpheme is the least structurally complex and the possessive morpheme is somewhere in the middle. See Appendix A for the syntactic structures of these morphemes.

[13] The comparison group children did not differ significantly in their ability to produce any of the three morphemes.

Similarly table 10a shows a comparison between the three morphemes in how the children in both groups omitted these morphemes.

Table 10a: A comparison of percent omitted productions for all participants

Morphemes	N	Mean	Minimum	Maximum	Mean Rank	
Plural	10	12.85	0.00	63.64	1.50	
Possessive	10	25.02	0.00	100.00	1.90	*p- value*
3rd. p. sing	10	45.92	0.00	100.00	2.60	0.021

The data in this table shows that the children in this study did significantly omit one or more morphemes more than the other(s). This means that there is a significant difference between how often one morpheme was omitted compared to how often another morpheme was omitted but this test does not tell us which two morphemes differ significantly. In order to determine where the significance lays we need to further compare the differences between the morphemes. Table 10b shows a comparison of these morphemes, again by using the Wilcoxon repeated measures test. The morphemes are compared on a two-by-two basis where one morpheme is compared to one other morpheme, such that for example the plural morpheme is compared to the possessive morpheme.

Table 10b: A two-by-two comparison of percent omitted morpheme productions

Morphemes	N	Mean Rank	*p-value*
Plural vs. Possessive	10	4.60	0.128
		2.50	
Plural vs. 3rd p. sing.	10	5.50	0.011
		1.00	
Possessive vs. 3rd p. sing.	10	3.83	0.128
		5.00	

Table 10b shows that the only significant difference between the morphemes for omission errors is between the plural morpheme and the third person singular present tense morpheme ($p = 0.011$). It appears that the children omitted the third person singular present tense morpheme significantly more often than the plural morpheme. Also since this difference was not found to be significant for the comparison group children than we can attribute this significant difference to the delayed group's omission errors. The children in the delayed group omitted the syntactically more complex 3rd p. singular morpheme far more often (omitted 89.09% of the time) than they omitted the syntactically less complex plural morpheme (omitted 27.59% of the time).

Discussion

In this study we investigated the role of phonemic perception and receptive morphology skills in the productive morphology skills of children with a severe phonological disorder in order to extend Paul and Shriberg's (1982) findings that children with PD have a morphological deficit that is independent of their phonological deficit. We predicted that the PD children would have morphological productions that matched their phonemic perception skills. In other words we expected that those children that had poor phonemic perception skills would also have delayed productive morphology skills. We also predicted that these children would have age-appropriate receptive morphology skills and that their mental representations for the morphology of their language are adult-like. Therefore we hypothesized that PD children have phonemic perception difficulties that underlay their phonemic production difficulties and this contributes to a processing overload during the production of grammatically complex parts of speech like morphemes.

We saw that during the story retell task four of the five speech-delayed participants had productive morphological delays, especially in the production of the age-appropriate the 3rd person singular morpheme. This supports Paul and Shriberg's findings that children with PD also have productive morphology delays. Interestingly though, in our study only two of the four children with delayed morphology also had poor phonemic perception. Therefore our prediction that PD children with delayed morphology also have poor phonemic perception is not fully supported, since two of the children that showed evidence of a morphological delay performed better than average on the SAILS phonemic perception task. This data suggests that PD children vary in their phonemic perception abilities and therefore we cannot predict productive morphological abilities from perceptual abilities alone. Although poor phonemic perception may still play a role in poor production, other factors are contributing to the morphological deficits evidenced in the PD children in this study.

According to the limited encoding capacity model, children with a phonological disorder are attributed with having a common underlying limitation in organizational ability, which accounts for the relation between their morphological and phonological deficits (Panagos et al., 1979). Panagos and his colleagues argue that language is organized in the brain as hierarchies of syntactic, morphological, and phonological elements. They believe that speech delayed children have difficulty managing hierarchical complexity during encoding which results in the loss of phonetic accuracy in the production of complex morphemes. Complex morphemes, as we described earlier, are morphemes which add a consonant to the word. These are thought to be more phonetically or motorically complex than simple morphemes which add a syllable to the word or simply change a consonant or vowel in the word. It is thought that the task of producing complex morphemes creates

competing demands for processing resources at higher linguistic levels and speech delayed children manage this difficulty by producing simplified morphemes.

The data collected in this study on the morpheme productions of PD children provides evidence for the limited encoding capacity model. The PD children appeared to have a limited processing capability because as the morphological complexity for the production of complex morphemes increased from the plural marker (stage II) to the possessive marker (stage III), to the 3rd person singular marker (stage V+), their phonological errors increased. For example the plural marker was omitted from obligatory contexts 27.59 %, whereas the possessive marker was omitted 62.86% of the time and the later acquired 3rd person singular marker was omitted 89.09% of the time. Therefore these data show that the processing of more syntactically complex morphemes causes more production difficulties for children with a phonological disorder.

The data provides interesting descriptive information about PD children's productive morphological abilities; however the data itself does not necessarily tell us anything about their underlying mental representations for grammatical morphemes. The question is, in addition to their phonological delay do PD children also have a language delay or does their phonological delay simply interfere with their production of grammatical morphemes? Whitacre, Luper & Pollio (1970) suggested that PD children have a single underlying organizational deficit, or a global language deficit, that is caused by a breakdown in the phonological system (Panagos & Prelock, 1982). If PD children indeed have a general language deficit that includes non-adult like mental representations for the grammatical morphemes of their language, than we should expect these children to have poor receptive morphology skills, as is evidenced in children with SLI.

The literature on SLI children shows that these children have poor receptive morphology (Rice et al., 1999). In fact poor receptive morphology is a predictor of poor productive morphology in children with SLI. Children with SLI have many productive morphology problems such as difficulties producing tense-marking morphemes. Research shows that these children have non-adult like mental representations for tense and therefore morphemes like 3rd person singular are optionally produced (Rice et al., 1998). Recent research shows that only 11-15% of children with persisting speech delay also have SLI (Shriberg et al., 1999), and therefore there is no reason to believe that these two groups of children have the same mental representations for grammatical morphemes. The data gathered in this study on the receptive morphology skills of children with PD show that these children do not have difficulties perceiving and interpreting grammatical morphemes. In fact the five speech-delayed children received a mean ranking of 92nd percentile on the TACL-III grammatical morphemes subtest which is well above average. Therefore we may assume given these test results that the PD children in this study did not have poor receptive morphology, and therefore receptive morphology is not a predictor of poor productive morphology in the PD population. If good receptive morphology is an indicator of adult-like mental representations than we can assume that the PD children in this study do not have a delayed system for representing grammatical morphemes. This suggests that although deficits of phonological performance appear to impair productive morphology in PD children, the reason for the productive morphological errors is not due to ill-constructed mental representations for the morphemes. Rather these children seem to have adult-like mental representations, only they are not able to produce the morphemes because of a limited processing capability.

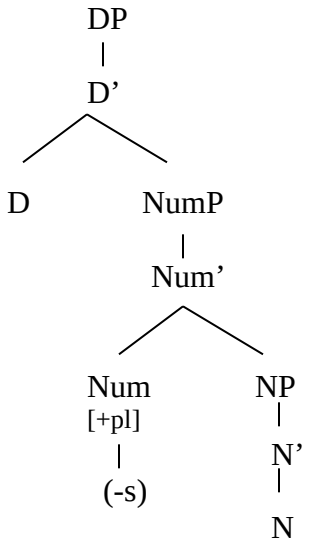
Conclusion

In summary, this study has examined relations between phonemic perception, receptive morphology and morphological production in children with severe phonological impairments. We looked at these factors in attempt to extend previous findings that children with phonological impairments also have productive morphological delays. We found that four of the five PD children in this study had an important morphological delay. In addition we found that all of these children have good receptive morphology skills, which lends support for the idea that these children have adult-like morphological representations. We also found that three of the five speech-delayed children had good phonemic perception skills and therefore their morphological deficits could not be attributed to poor perceptual skills. Since the PD children tested in this study had more difficulty with the production of the more syntactically complex 3rd person singular present tense morpheme than the less grammatically complex plural and possessive morphemes, this data supports the 'limited encoding capacity model' proposed by Panagos et al. (1979) whereby these children appear to have difficulties with morphemes that require greater processing abilities.

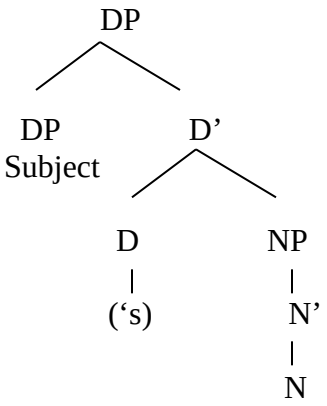
Appendices

Appendix A: Syntactic Trees for Morphemes

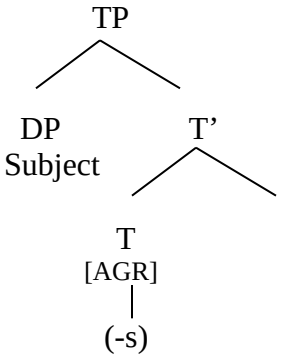
1) Plural marker (Ritter, 1992)



2) Possessive marker (Abney, 1987)



3) 3rd person singular agreement



Appendix B: Story Scripts for the Story Retell Task

"The Baby Sitter"

The little girl **waves** bye-bye!
Mommy and Daddy **wave** bye-bye!

They **get** a snack.
The baby sitter **pours** the milk, and the girl **brings** the cookie**s**.
They **sit** on the couch.
The baby sitter **plays** with puppet**s**, and the girl **eats** the cookie**s**.

They **make** a truck with block**s**.
The little girl **pulls** the truck.
The doggie **watches**.
The toy**s watch** too.

They **read** a book, and the doggie **sleeps**.
Look, a parade!
They **march** upstairs.
The girl **plays** the drums, and the baby sitter **plays** the flute.

The baby sitter **puts** pyjamas on the girl.
They **play** in the girl**'s** room.
She has a lot of toy**s**.
There's a book, an alligator, some crayon**s**, and some block**s**.

The girl **pees** and **brushes** her teeth.
The baby sitter **brushes** the girl**'s** hair.

They **read** a story.
The babysitter **goes** downstairs and **falls** asleep.
The girl **wakes** up and **sneaks** downstairs.

She **goes** back to bed.
Mommy and Daddy **come** home, and **say** goodnight.

"Caillou: One or Many"

This **is** Caillou.
This **is** his hat.
This **is** his shoe.
Oh look! More shoe**s are** in the closet!

Caillou **is playing**.
Here **is** Caillou**'s** block.
Look! More block**s are** behind the cushion!

This **is** Caillou**'s** truck.
Look, more truck**s are** in his toy box!

Caillou **is** hungry.
Here **is** Caillou**'s** banana.
Oh look! More banana**s are** behind the box!

Look, there **is** a frog.
Caillou **is drawing** the frog.
Here **is** Caillou**'s** crayon.
Oh look! More crayon**s are** behind the bear!

“Man’s Work!”

The boy**’s** toy**s are** everywhere!
Daddy and the little boy **are going** to clean the house.
It **is** a mess!

They **are throwing** the toy**s** in the toy box.
Daddy **is wiping** the table.
The boy **is wiping** the chair.
They **are having** fun.

Daddy **is vacuuming** the boy**’s** leg!
He **is laughing**.
The boy **is vacuuming** Daddy**’s** feet!

They **are washing** the dish**es**.
Daddy **is bringing** the plate**s**, and the boy **is bringing** the bowl**s**.

Uh-oh. Mommy**’s** plant is on the floor.
Daddy **is sweeping** up dirt, and the boy **is pushing** a big broom.
They **are cleaning** the bathroom.
Daddy **is washing** the tub and the boy **is washing** the sink.

They **are polishing** their shoe**s**.
Look: Mommy**'s** shoe**s**, Daddy**'s** shoe**s**, the boy**'s** shoe**s.**
They **are doing** the laundry.
The boy **is putting** the clothes in the washer.

Now they **are hanging** the clothes up to dry.
Here **are** the boy**'s** sock**s**, and here **are** Daddy**'s** pants.
The boy **is folding** the clothes.
Daddy **is ironing** them.

All done!
They **are having** some juice.
They **are** happy to be finished.

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