UNIVERSITY OF ALBERTA

THE PSYCHOLOGICAL REALITY OF PHONOLOGICAL UNITS FOR SPEAKERS OF AN UNWRITTEN LANGUAGE

by

GRACE E. WIEBE

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To

my husband

ABSTRACT

A series of experiments were carried out to assess the segmentation strategies of native speakers of an unwritten language called Plautdietsch (PD), spoken in south-western Saskatchewan. These speakers were literate in English (and thus presumably able to segment phonemically in that language) but illiterate in their mother-tongue (and thus not guided by orthographic norms in the segmentation strategies under investigation). Subjects participated in a segmentation and spelling task, as well as in two of three deletion-recognition tasks.

In the segmentation/spelling task, general segmentation patterns emerged suggesting that a unit's environment as well as the syllable's composition and complexity affected subjects' segmentation abilities. Postvocalic resonants formed part of the nucleus and were more likely to form a unit with the vowel in words with more complex onsets and codas. It was proposed that PD has three types of nuclei: 1) long and outgliding diphthongs (98% cohesive); 2) vowels plus /r/ and ingliding diphthongs (65%) and 3) vowels plus /l/ and nasals (27%).

The results of the deletion-recognition tasks, which confirmed the findings of the segmentation task, suggest that postvocalic resonants form part of the nucleus in PD and that there is a hierarchy of nuclear cohesiveness, depending on the resonant. In particular, postvocalic /r/ displayed the most vowel-cohesion in PD, which is similar to Derwing and Nearey's (1991) results for English. However, unlike the English findings, PD postvocalic nasals and /l/ adhered to the vowel with approximately equal strength. The diphthong type and embeddedness was found to affect its cohesiveness. Initial and final fricative-stop clusters were less cohesive than stop-fricative clusters in both positions. A gradation of separability

was observed even in so-called monosegmental units such as affricates and palatal consonants.

These results challenge the notion that syllables have clearly delineated constituents, as implied by the hierarchical models of syllable structure. A scalar bonding model, allowing for fluctuations between units, is suggested as a more acceptable alternative for PD syllables. The primacy of the phoneme for adults literate in an alphabetic system is also questioned, since not all segmentations corresponded to phonemic norms.

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I. INTRODUCTION

Phonological units[1] have long been the topic of linguistic investigations. The largest body of work on phonological units has involved the individual segment, much of the effort concentrating on whether or not particular segments in certain languages can be grouped together on a psychological basis, i.e., are phonemes or not. Of late, there has been a renewed interest in the syllable as a basic linguistic unit, due, in part, to the fact that syllables rather than phonemes are accessible to illiterates, preliterates and those literate in non-alphabetic systems. Other linguistic endeavours have involved subsyllabic units, which are intermediate in size to the syllable and the phoneme. As this thesis will investigate the nature of subsyllabic units and the composition of the syllable in a Low German dialect, it will be useful to introduce models of the syllable as well as label and define the subsyllabic units of interest. The next paragraph will propose "working" definitions of several phonological units. The reader should keep in mind that the terms defined here are constituent labels to facilitate discussion and may subsequently change.

The **syllable** may contain one and only one vocalic peak with optional preceding and succeeding consonants. Syllable boundaries will remain undefined as the topic is outside the scope of this dissertation, but see Fallows (1981), Selkirk (1982), Treiman and Danis (1988), Treiman and Zukowski (1990) for a discussion of syllable boundaries in English; for German syllable boundaries see Venneman

[1] The term is used here in the sense suggested by Morais et al. (1987), that is, they are non-prosodic sound-based units (as opposed to meaning based units) of any size.

(1988a) and Hall (1989). Various **subsyllabic** or intrasyllabic[2] units have been proposed (see Venneman, 1988a, for a comprehensive list), but this study will only include discussion of the onset, rime, body, nucleus and coda.[3] The **nucleus** or peak,[4] which forms the "core" of the syllable and, therefore, must be present, consists of a vowel, a diphthong or a syllabic consonant and may contain a postvocalic resonant.[5] The **coda** follows the nucleus and may or may not contain postvocalic resonants. The **onset** precedes the nucleus and is composed of any prevocalic consonants.[6] The **rime**[7] consists of a vowel or diphthong and any following tautosyllabic consonants. The vowel and any preceding tautosyllabic consonants constitute the **body** or head.[8]

A. Syllable Models

All of the models proposed below are of varying theoretical types, but have one thing in common: they are all formulated under the assumption that they are

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[2] Both subsyllabic and intrasyllabic are used to indicate phonological units that are larger than a single segment but smaller than a syllable.
[3] The terms "onset" and "coda" were introduced by Hockett (1955) and "nucleus" by Pike in (1947).
[4] The term "nucleus" rather than "peak" will be used in subsequent discussions.
[5] Selkirk (1982) has proposed that liquids and nasals may form part of the nucleus if the vowel is simple or nondiphthongized. Treiman (1984) and Derwing et al. (1987b) have found evidence for inclusion of resonants in the nucleus.
[6] Some linguists such as Selkirk (1982) include prevocalic resonants in the onset, others such as Dow (1987) and Derwing et al. (1987) found that in English, only prevocalic glides are treated as part of the nucleus in segmentation, deletion and substitution tasks.
[7] The term "rime" will be used for the subsyllabic unit, in order to distinguish it from the term "rhyme" which indicates a sound similarity between two words (Morais et al., 1987).
[8] Venneman (1988) uses the term "body" for the onset plus nucleus. Although I have use the term "head" elsewhere (Wiebe and Derwing, 1990), I will use the term "body" in the interest of consistency.

psychologically valid for actual language users in real-time. This is by no means a comprehensive list of syllable types, yet each has been included because of some support in the literature.

1. M1. Whole Syllable

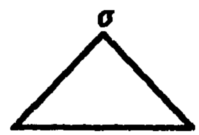

Figure 1. M1. Whole Syllable

The first model of the syllable to be considered is the syllable as an indivisible unit. For literate speakers of an alphabetic system, this would appear to be a counter-intuitive model, but for some speakers the syllable is not readily broken down into units smaller than the syllable. Barton (1985) notes that the syllable is easy for non literate adults and preliterate children to access and manipulate. Even three and four year old children can segment words into syllables, but have difficulties segmenting any farther (Rosner,1974; Liberman et al., 1074; Fox and Routh, 1975).

2. M2. Bipartite

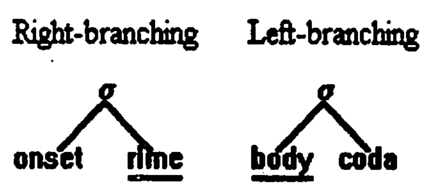

Figure 2. M2. Bipartite

The second model divides the syllable into two units, either the onset and the rime, which would produce a right-branching model, or the body and coda, a left-branching model. Branching direction is indicated by the portion of the constituent containing the nucleus, which is underlined here. The onset and rime are units that are recognizable and manipulable by speakers of languages which have a literary tradition in which alliteration and/or rhyme are familiar poetic devices (Derwing, et al. 1988). This would mean that these units are accessible to most speakers of western languages, including preliterate children (Bradley and Bryant, 1983) and illiterate adults (Morais, et al., 1986, Cary, et al., 1987). Although, there has been speculation that the onset/rime division and, hence, the right-branching syllable, is universal, some linguists have found evidence for a left-branching syllable structure in Korean (Youn, 1990; Derwing et al., 1992) and Japanese (Kubozono, 1989).

3. M3. Two-Tiered

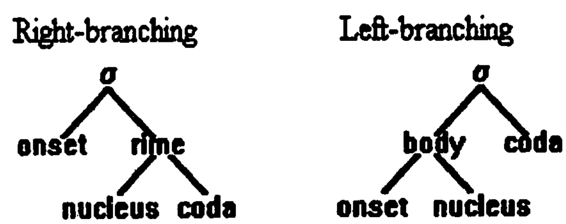

Figure 3. M3. Two-Tiered

The third syllable model would include a further division thus producing a second level or tier. This would mean the division of the rime into a nucleus and coda for the right-branching model, and, for the left-branching model, the division of the body into an onset and nucleus. In her dissertation, Dow (1987) found evidence for the onset, nucleus and coda as psychologically valid units and proposed at righ-branching syllable model for English.. In a series of experiments, Treiman (1983, 1984, 1985) also demonstrated the psychological reality of the onset and the coda. Speech error research provides evidence for the nucleus as well (Shattuck-Hufnagel, 1983, 1986).

4. M4: Tripartite

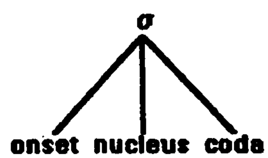

Figure 4. M4: Tripartite

The second and third models of the syllable (above) presuppose a hierarchical structure where each major branch consists of a bipartite division (e.g., syllable → onset + rime; rime → nucleus + coda). However, there could just as well be an initial tripartite division of the syllable into onset, nucleus and coda. As a non-language-specific syllable structure, a tripartite division might be feasible for all languages, as supposedly right-branching and left-branching syllable types have all three of these subsyllabic units. However, this fourth model of the syllable appears unacceptable in that it ignores the rime which appears to be widely accessible to speakers of "western" languages.[9]

[9] Perhaps "Indo-European" could be substituted for "western", but not enough evidence is available.

5. M5. String

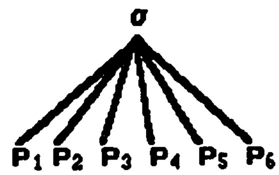

Figure 5. M4: Tripartite

Another or fifth model proposes that the syllable is composed of a string of phonemes with no intervening units. This is the general model of the syllable indirectly espoused by theoretical linguists such as Chomsky and Halle (1968). Traditionally, linguists have assumed that all normal adults of any language group could segment syllables into their separate phonemes. Indeed, this appears to be the case for speakers who are literate in alphabetic writing systems. Thus, for those speakers, a model which proposes a syllable consisting of a string of phonemes may be a viable one. However, as some linguists have noted, illiterate adults are not adept at isolating phonemes (Morais et al., 1987a), nor are adults who are literate in non-alphabetic systems (Read et al., 1986). Therefore, a model that describes the syllable as a string of phonemes, may indeed describe the units that are psychologically real for literate speakers, but does not appear to describe an appropriate syllable structure for analphabetics and "nonalphabetics".[10]

[10] Nonalphabetics is coined here to mean those who are literate in a writing system not based on an alphabet.

6. M6, M7, and M8. Bipartite/String, Two-Tiered/String, and Tripartite/String

M6: Bipartite/String

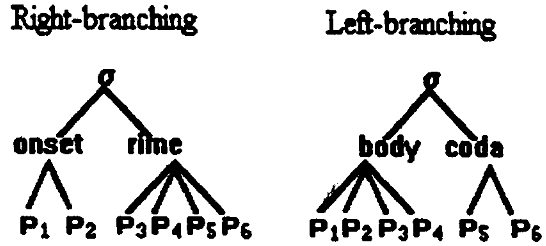

Figure 6. M6: Bipartite/String

M7: Two-Tiered/String

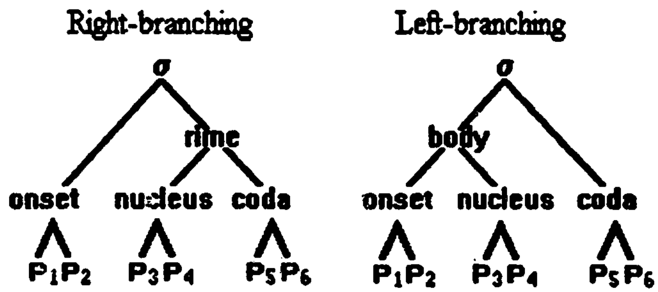

Figure 7. M7: Two-Tiered/String

M8: Tripartite/String

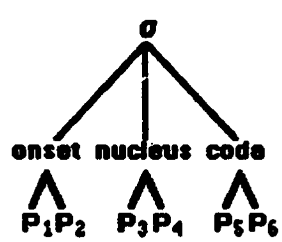

Figure 8. M8: Tripartite/String

If we assume that the terminal nodes of the Bipartite, Two-Tiered, and Tripartite Models (M2, M3, and M4) can be further subdivided into phonemes, then the new models (M6, M7, and M8) will combine the hierarchical models described above with the String Model (M5). For example, the Bipartite/String model will either be right- or left-branching with a further division of the rime or the body into a terminal string of phonemes. These three 'combination' models, which incorporate the String model with hierarchical models, and the String model itself, were formulated under the assumption that language users can isolate, manipulate, or somehow identify all of the units in question. As mentioned above, the universal psychological reality of the phoneme has been questioned (Derwing, Nearey & Dow, 1987a)[11], so any model which incoporates phonemes should also be questioned.

7. M9. Scalar Bonding

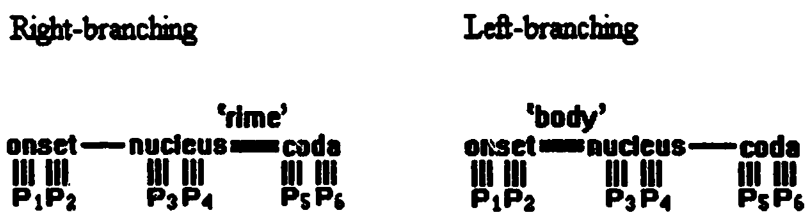

Figure 9. M9. Scalar Bonding

The scalar bonding model (cf. Vennemann, 1988b; Derwing et al., 1988) relies on the strength of the bonds between phonemes and avoids the sharp boundaries between phonological units implicit in the hierarchical models discussed above. In this model the relatively strong bonds connect the members of

[11] This topic will be discussed in some detail below.

the 'rime' or 'body', depending on the language type as shown by the double bond-lines in Figure 9. For right-branching languages the interface between onset and rime appears to have the weakest bond, as shown by a single bond-line in the figure. Even three-year-old speakers of such languages have little difficulty detecting rime (Bryant et al., 1989) and five-year-old speakers are able to separate onset and rime (Dow, 1987). Further, the onset, nucleus and, to some extent, the coda form fairly cohesive units, as shown by the triple bond-lines. Users of right-branching languages tend to have a harder time separating the consonants of the onset than those of the coda and also find it difficult to separate members of the nucleus. In the nucleus we also find a gradation of the tightness of the bonds, depending on whether the segments adjacent to the vowel are glides or other nonvocalic resonants (Derwing, Nearey & Dow, 1987b), but these details are not reflected in the figure.

Although, not much work has been done on languages with left-branching syllables, it appears that separation of the syllable into body and coda is relatively easy in Korean (Derwing, Cho and Wang, 1991; Derwing, Yoon and Cho, in press) and there is speech-error evidence for a similar segmentation in Japanese (Kubozono, 1989). As no work has been done on other subsyllabic units in such languages, it is not possible to tell which other units form close or weak bonds for speakers. Clearly, more work needs to be done before a non speculative statement about left-branching syllables can be made.

8. Summary of Syllable Models

The definitions and syllable models were outlined above to facilitate further discussion. An attempt was made to include experimental evidence in the formulation of the nine syllable models in order for the work to have a behavioral (psycholinguistic) rather than purely theoretical (linguistic) basis. It appears that some models have more validity for certain groups of language users than others. For example, illiterates or preliterates may be operating on a level represented by the whole syllable model (M1), while literate speakers may not. Further, as more experimental data with different age and language groups are collected and new evidence is amassed, the above models will undoubtedly change.

B. The Psychological Reality of Phonological Units

Various experimental techniques have been used to explore the psychological reality of phonological units. The types of experiments which have been used include word-blending and syllable-inversion games, phoneme-counting, subsyllabic unit-counting and syllable-counting tasks, deletion and substitution tasks, similarity judgments and spelling tasks. Some of the experiments which directly pertain to the present study will be outlined here.

The internal structure of English syllables has been explored by Treiman (1983b) using word-blending games (her Experiment 7). Native English-speaking adults were taught to blend two monosyllabic nonsense words (CCVCC structure) into the following four combinations: onset+rime (flirz + gruns → fluns), first consonant+rest of word (flirz + gruns → fruns), body+coda (flirz + gruns → flins), and first part of word+final consonant (flirz + gruns → flirs). Subjects found it easier to learn the task involving onset-rime blends and made significantly fewer errors on the onset-rime blending game than the other games. Thus, Treiman's subjects displayed an implicit awareness of onset and rime.

Treiman (1983b, 1986) reasoned that if syllables are treated as composed of onset and rime constituents, then games that keep these components together should be more easily learned. Subjects who were taught word-games in which two real or nonsense CVC(C) syllables were blended together made fewer errors learning the game which divided the two words at the onset-rime boundary (packed + nuts → putts) than games in which the division was between body and coda (packed + nuts → pats), or at a morpheme boundary (packed + nuts → packs). Again, this suggests that English speakers are aware of the subsyllabic units, onset and rime.

Treiman (1988) tested syllables whose onset and peak (or body) were linked together by distributional constraints. In a blending task, subjects kept the body intact only 10% of the time, preferring to blend the onset of one word with the rime of the second. The evidence indicates that in English, whereas nucleus and coda readily grouped together into a unit referred to as the rime, the onset and nucleus are unlikely to form a unit. The results of Treiman's blending tasks consistently suggest that English syllables are composed of two main parts, the onset and the rime.

Again using word-games, Treiman (1986) demonstrated that onsets form cohesive units. English-speaking university students were taught to break monosyllabic words with initial consonant clusters (CCVC and CCCVC) into two words. Subjects found it easier to learn games that did not break up an initial cluster than those that did. Although all of Treiman's word-games tended to focus on the onset and rime, her work leaves little doubt that both the onset and the rime are psychologically real to English speakers.

Dow (1987) used deletion and substitution tasks to show that the syllable was composed of relatively well-defined units of onset, rime, nucleus and coda. Her results indicate that even children in kindergarten have a fairly well established notion of onset and rime as these subjects correctly deleted the onset from the rime 39% of the time. In a substitution task, Dow also found that the rime was further divided into nucleus and coda, suggesting that the structure of the syllable was hierarchical and that English syllables were right-branching.

The studies by Treiman and by Dow (outlined above) were ground-breaking studies in that they explored the possibility that there were units, accessible to language users, that were smaller than the syllable but larger than the phoneme, and that these units were fairly well defined. Once the psychological reality of subsyllabic units had been established, later studies by the same authors concentrated more on the composition of these units. These later studies (discussed below) suggest that the structure of subsyllabic units is less well defined than previous studies would indicate and that their internal composition depends on context.

To capture the apparent fluctuations of some syllable components, Derwing, Nearey and Dow (1987b) introduced the idea of consonant and vowel stickiness to account for gradation effects. In deletion and substitution identification tasks, they found that whereas some pre- and postvocalic resonants were more likely to adhere to the vowel and thus were said to be V-sticky, other resonants tended to adhere to the consonant or were C-sticky.

Derwing et al. (1988) noted that there was a pattern of vowel-stickiness for resonants. Liquids were more vowel-sticky than nasals and resonants more vowel-sticky than obstruents. This pattern was validated in three different types of experiments: (1) experimental word-games (Treiman, 1984), (2) substitution-pattern identification tasks (Derwing, Nearey and Dow, 1987b) and (3) syllable boundary tasks (Treiman and Danis, 1988; Derwing et al., 1991).

Treiman (1984) suggested that the boundary between nucleus and coda is affected by the type of post-vocalic consonant. When adult subjects were asked to blend two nonsense VLC syllables to form one new syllable, they linked the liquids with the vowel significantly more often than with the final consonant. Treiman also found that subjects treat postvocalic obstruents differently from liquids and nasals. She noted that the tendency to link consonants with vowels decreases from liquids to nasals to obstruents. Her results suggest that postvocalic liquids are part of the nucleus, obstruents are part of the coda and nasals are bound both to the nucleus and the coda with approximately equal strength.

Using both substitution tasks (for the nucleus and onset) and a deletion task (for the coda), Derwing, Nearey and Dow (1987b) found that whereas prevocalic resonants are generally more consonant- than vowel-sticky, postvocalic resonants show the opposite tendency, that is, to be more vowel-sticky. They also noticed a trend for glides in both pre- and postvocalic positions to be more closely bound to the vowel, for nasals to be more closely bound to the consonant and for liquids to display intermediate amounts of vowel-stickiness.[12] This lead them to suggest that the structure of the syllable may best be described by a scalar bonding model rather than a strictly hierarchical one. Derwing and Nearey (1990) corroborated these results and reiterated the proposal that alternatives should be sought to a strictly hierarchical model of the syllable.

Syllable-boundary studies also shed some light on the question of whether the constituency of subsyllabic units is sharply delineated or not. Treiman and Danis (1988), while investigating the boundary of English syllables using a syllable inversion task, noticed that subjects included liquids, /l/ and /r/ with the first syllable, obstruents with the second, and nasals with either. Their results, once

[12] This result is similar to the findings of an earlier study by Treiman, 1984, and a subsequent one by Derwing and Nearey, 1990.

again, indicate that the composition of and division between nucleus and coda may depend on the segments involved.

In a 'pause-break' experiment, Derwing et al. (forthcoming) offered English-speaking subjects two or three possibilities for separating disyllabic words and asked them to pick the most natural-sounding break. After stressed lax vowels, subjects preferred the break after the medial consonant when that consonant was a resonant and before the medial consonant if it was an obstruent. This suggests that resonants form a closer bond with such vowels than resonants do. Subjects further distinguished amongst the resonants. Medial /r/ was included most often (76%) with the first syllable, nasals least often (52%) and /l/ more often than nasals but less often than /r/ (62%). Even in a task not primarily designed to examine the constituency of the nucleus and coda, the authors found evidence that resonants in post-vocalic positions display a differential vowel-stickiness.

Spelling tasks also reveal a vowel-stickiness gradation amongst the resonants. Treiman (in press) asked English-speaking first grade children to spell nonsense words consisting of CVC syllables in which the VC sequence ended with /ɑr/, /ɛl/, /ɛm/, /ɛn/, /ɛf/, /ɛs/, all letter-name sequences. She found that more than 50% of the spelling errors for words ending in vowel plus liquid, /ɑr/, /ɛl/, were letter-name errors (children spelled the words with just the letters <r> or <l> to represent the vowel-liquid nucleus, rather than using a vowel plus <r> or <l>), but less than 10% of the vowel-nasal or vowel-obstruent sequences were letter-name errors. She concluded that letter-name spelling errors were more common for highly cohesive units such as the tightly-bound vowel-liquid sequences. Interestingly, she does not attribute the difference in the cohesiveness of postvocalic resonants to the fact that liquids are more vowel-like and hence part of nucleus, and that nasals are more coda-like, but continues to discuss vowels plus liquids, nasals, or obstruents as part of the rime with no mention of any further subdivision of the rime. Clearly, the results suggest such a subdivision may be necessary.[13]

In summary, the pattern that emerges from word-games, substitution identification, and syllable boundary tasks is that in English postvocalic resonants display varying degrees of vowel-stickiness. There is a progression in V-stickiness from glides, which are most V-sticky, to liquids (/r/ is more V-sticky than /l/), to nasals. Further subjects tend to treat liquids as part of the nucleus and nasals as part of the coda.

In the preceding paragraphs the discussion has centered on subsyllabic units, their composition and their validity. Let us now turn to a discussion of the psychological reality of phoneme-sized units.

In a syllable counting task involving four age-groups (kindergarten-aged children, younger and older grade-one students and high-school students), Dow (1987) found that even the youngest age-group (kindergarteners) were able to correctly count syllables 58% of the time and that all age groups could count syllables more easily than subsyllabic units or phonemes. Dow also found that children from kindergarten to high school had more difficulty counting phonemes than syllables (22% correct vs. 70%) and that subsyllabic units were also easier to count than phonemes (onset + rime, 38%; onset + nucleus + coda, 35%; phonemes, 22%). These results are rather surprising, particularly for the high school students (51% correct phoneme count), as it has been assumed that English-speaking students in upper grades could readily manipulate phonemes.

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[13] Treiman later says that intrasyllabic units play a part in linking speech to print and subsequently mentions that /ɛl/ is a peak, but never goes so far as to tie the results into a subdivision of the rime.

Other studies with children also indicate that the phoneme is not as accessible as previously thought. Liberman et al. (1974) trained, then tested two groups each of preschoolers, kindergarteners, and first graders. One group learned to tap out either the number of phonemes in monosyllabic words one to three phonemes in length, the other group, the number of syllables in words varying in length from one to three syllables. In the "syllable" group, 46% of the preschoolers and 48% of the kindergarteners could segment syllabically, and at the grade one level almost all (90%) of the children could segment by syllables. By contrast, in the "phoneme" group none of the preschoolers could segment into phonemes and only 17% of the kindergarteners. However, in grade one 70% were able to segment phonemically. This, the authors contend, suggests developmental segmentation abilities in children or the effects of explicit language instruction in grade one.

Morris (1983) also examined children's phoneme awareness by means of a tapping task like Liberman et al's above. The 19 first graders who were tested in the first month of school on average could correctly segment 12 out of a total of 42 words or 29%.[14] His results suggest that children who are just learning to read an alphabetic system have not yet fully developed an awareness of phonemes.

In a study by Treiman and Baron (1981) where 17 first grade children using checkers as counters were asked to count syllables and phonemes in nonsense words (both 1-3 units in length), it was found that syllable segmentation was uniformly easier than phoneme segmentation for all the children (syllable counting 69% and phoneme counting 42% correct). A number of second graders (n=14)

[14] These results have been calculated through his published scores. His paper focused on a correlational analysis between awareness of phonemes and awareness of words, so all results were published as r-values.

also participated in the phoneme counting task. Both the proportion of correct answers (Grade 1, .42; Grade 2, .58) and the number of children who passed the test[15] (Grade 1, .35; Grade 2, .57) increased significantly from the first to the second grade groups.

Taken at face value, there appears to be some discrepancy in the results of the previous three studies. The percent scores that the first graders achieved in Treiman and Baron's phoneme counting experiment are higher than those of the first graders in the study by Morris (1983), and less than those in Liberman et al.'s 1974 study. However, the children in each study were tested at different times during their first year of school. Morris' subjects with 29% correct were tested in the first month of the school year, while Treiman and Baron's subjects, who had 42% correct, were tested mid way through the school year in January and February; Liberman's subjects were tested at the end of grade one and had 70% correct. This could be indicative of a developmental trend, but given that the subjects seem to be in similar age groups,[16] the likelier reason is that as the children gain familiarity with the printed word through learning to read and write in an alphabetic system, their awareness of phonemes and their ability to segment into phoneme sized units would increase proportionally. The effects of literacy and orthography on phonological experiments are discussed below.

C. Literacy and Phonological Experiments

Research into the psychological reality of phonological units has been hampered by the interference of orthography on investigative studies (Jaeger, 1980;

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[15] A child passed the test if the score indicated that there was less than 5% random guessing.
[16] Morris' subjects had an average age of 6 years, 9 months and Trieman's, 6 years, 6 months. Liberman does not report the ages of her subjects.

Derwing & Nearey, 1981; Dow, 1981; Derwing, et al., 1986). In 1976, Derwing found unusual responses in his morpheme recognition study and Smith (1986) demonstrated that this is due to spelling knowledge.

The interaction of sound and spelling can even influence fundamental tasks such as speech segmentation. Ehri and Wilce (1980) asked 24 English-speaking fourth-graders to segment seven pairs of words like **pitch-rich** and **badge-page** in which one of the words in the pair was spelled with an extra letter. During segmentation, 57% of the subjects identified an extra sound for the words spelled with an extra letter. In a second experiment, one group of fourth-grade subjects learned to read and spell nonsense words with an extra letter (e.g., **zitch**) and a control group learned words without it (e.g., **zich**). A spelling task revealed that the group trained with extra letters included them in 89% of their spellings, whereas 93% of the control group omitted them. In a segmentation task, extra letters were almost always produced by the "extra-letter" group. The authors concluded that the visual forms of words influence speaker's conceptualization of words' segments.

Evidently, speakers do not spontaneously acquire the ability to segment speech into phonemes. This ability requires specific training of the sort that is provided when one is learning to read and write an alphabetic system (Morais et al., 1987). Read et al. (1986) found that the successful manipulation of phonemes was dependent upon literacy in an alphabetic system and not literacy per se. Mann (1986) noted that there was a delay in the phoneme segmentation skills of Japanese first-graders, who learn to read a syllabary. Gleitman and Gleitman (1979), who compared the effectiveness of learning to read logographic, syllabic and alphabetic writing systems, found that logography was easier than syllabary, and that both were easier than the alphabetic system. Whatever writing system children encounter, they must learn which particular unit of speech is encoded. It would appear that the most difficult to acquire is the phonemic concept underlying the underlying alphabet.

Evidently for literate speakers metalinguistic knowledge of phonology is difficult to separate from knowledge of orthography. Morais et al. (1979) observed that Portuguese illiterates had difficulty with a segmental analysis of speech (only 19% correct in segment addition and deletion tasks), yet ex-illiterates, who had learned to read late in life, demonstrated a relative ease with segmentation tasks (an average of 72% correct). Using similar tasks involving the addition or deletion of a segment, Read et al. (1986) observed a difference between literate Mandarin speakers who had learned to read *pinyin*, an alphabetic system, and those who had not. Derwing et al. (1991) report that monolingual speakers of Taiwanese (which does not have a phonemic transcription scheme) did not distinguish between onset-rime blends and head-coda blends. The authors suggest that this may be ascribed to the subjects' inability to analyze CVC syllables into smaller units, as this finding is consistent with Read et al.'s results. Thus, awareness of phonemes appears to be dependent upon the speakers ability to read an alphabetic orthography.

With the exception of the work by involving Mandarin speakers by Read et al. (1986), illiterate Portuguese speakers by Morais et al. (1989), Taiwanese speakers by Derwing, Cho and Wang (1991) and in Korean speakers by Derwing, Yoon and Cho (in press), much of the experimental work on phonological units has been conducted using literate speakers of English. Therefore, cross-linguistic validation without the interference of an alphabetic orthography is called for. This dissertation is an attempt to fill this need by using a group of speakers of a German dialect who are not literate in their mother-tongue. The following paragraphs will briefly describe the work undertaken.

D. Overview of Remaining Chapters

Two separate studies were conducted to investigate the psychological reality of phonological units for speakers of Plautdietsch, which is an unwritten Low German dialect spoken in southern Saskatchewan. All the subjects are literate in English, and some in High German, thereby eliminating problems which arise when dealing with illiterate subjects. Unfortunately, the very fact that the subjects are literate creates potential confounding variables due to orthographic effects. For this reason an attempt was made to reduce any effects caused by visual forms of words by conducting all tasks orally and in Plautdietsch.

Chapter 2 describes a segmentation task which was designed to ascertain if a group of people who are literate in an alphabetic orthography and, therefore, presumably able to segment words into phonemes, can perform a segmentation task in another language. It was thought that the subjects chosen would have had no reason to analyze Plautdietsch into individual segments (as they must have done when learning to read and write English), so might, in fact, segment words into something other than phoneme-sized units. This chapter also contains a description of a spelling task to determine if the graphemes produced correspond to phonemes or to subsyllabic units. The first set of results indicate that although the segmentation was usually at the phoneme level, there was evidence of segmentation into subsyllabic-sized units and that these units correspond to onset, rime and nucleus. The spelling task confirmed these results, even though the mere fact of using an alphabetic orthography seemed to remind subjects that smaller units were possible, so that there was more phoneme-grapheme correspondence than would be expected from the segmentation task. Although the findings of this chapter were somewhat inconclusive, it does not diminish the fact that even though speakers of an unwritten dialect were able to transfer their ability to analyze words into phonemes from English (acquired when learning to read and write English) to another language, there was still evidence of other phonological units in the two tasks.

The next chapter, Chapter 3, outlines three deletion-recognition tasks which were designed to determine the composition and cohesiveness of subsyllabic units in Plautdietsch. The findings indicate that onsets are more cohesive than codas, that onsets and codas containing stop-fricative combinations are the most cohesive and that resonants form intermediate units in both pre- and postvocalic positions. A resonant following an initial consonant cluster appears to be more or less separate from either the initial cluster or the vowel. If there is any likelihood at all of a prevocalic resonant forming a unit, then it is with the preceding consonant, which would place it in the onset. Postvocalic resonants are more likely to form part of the nucleus, although there was a stronger tendency for /r/ to do this than for /l/ or nasals. A hierarchy of cohesiveness of nuclei containing long and short diphthongs was also observed. Even though two different age-groups, children and adults, were tested, it appears that the ability to read and write High German affected subjects' responses more than maturational factors. Finally, a scalar bonding model of the syllable (similar in nature to M9 outlined above) is proposed for Plautdietsch.

The final chapter presents a summary of the results and conclusions of two experimental chapters, a discussion of implications of the findings, and suggestions for future research.

II. SEGMENTATION AND SPELLING TASKS

The phoneme and the syllable are two phonological units which have long been regarded as readily accessible to the normal speaker-hearer. There is much evidence in the literature that adult language users can easily recognize and manipulate both these units. Previously researchers have investigated speakers' abilities to segment speech into sublexical units and have mainly concentrated on the phoneme or the syllable (Liberman et al., 1974; Fox & Routh, 1975; Hohn & Ehri, 1983; Morris, 1983; Perin, 1983; Barton, 1985, Mann, 1986). More recently research attention has turned to subsyllabic or intrasyllabic units, as some evidence has emerged suggesting that speaker-hearers can also identify and manoeuver intermediate units larger than the phoneme and smaller than the syllable (Treiman, 1984, 1985, 1986; Cutler et al., 1987; Bryant et al., 1989; Dow & Derwing, 1989; Bruck & Treiman, 1990).

There has been some evidence in the literature (Morais et al., 1989) that illiterates can manipulate syllabic size units, but have difficulty manipulating individual segments. Read et al., (1986) tested adults who were literate in Chinese characters only and others who were also literate in alphabetic spelling (Hanyu pinyin). The tasks consisted of adding or deleting initial consonants using real and nonsense words. There was a significant difference in ability to add or delete initial consonants between the alphabetic and nonalphabetic groups. Read et al. found that adults, who were literate in Chinese characters only, could not perform phonemic segmentation tasks, whereas those who had learned *pinyin* as well as Chinese characters could perform these tasks. The authors' conclusion was that it was not literacy in general that led to an ability to successfully manipulate speech sounds, but specifically literacy in an alphabetic system.

Identifying individual units from a continuous stream of speech is fairly difficult. Phonetic analytic skills that have been studied include segmentation tasks, which examine a subject's ability to divide words into constituent phonemes (Ehri & Wilce, 1980; Treiman & Baron, 1981; Dow, 1981, 1987); blending tasks, in which subjects blend two words into one, thus tapping their knowledge of sub-syllabic units such as onset and rime or body[17] and coda (Treiman, 1986; Derwing, 1991); deletion, addition and substitution tasks, which involve manipulating phonemes, onsets, nuclei, codas, rimes, bodies and margins (Morais et al., 1979; Perin, 1983; Treiman, 1985a; Content et al., 1986; Dow, 1987).

Some of the evidence for phonological units arises from investigations into children's reading and spelling ability. Wagner & Torgesen (1987) survey current literature in this area and conclude that not only does phonological awareness play a causal role in the acquisition of reading, but that learning to read also plays a causal role in the development of phonological awareness. The circular argument developed in Wagner & Torgesen's paper is partially resolved by Morais et al. (1987) who claim that while segmental analysis skills and the acquisition of literacy in an alphabetic system influence each other, literacy causes phonological awareness and not vice versa (see also Fox and Routh, 1984).

Other authors (such as Read et al., 1986, discussed above) have also suggested that knowledge of an alphabetic orthography affects phonological knowledge. Perin (1983) found that poor spellers had more difficulty with a segmentation task than good spellers, irrespective of their reading skills. Perin tested the segmentation skills of 14-15 year-olds grouped by spelling and reading

[17] The terms body and head are used to designate a CV unit.

abilities. There were two tasks, a Spoonerism task and a segment judgement task. In the first task, the poor spellers (but good/poor readers) made more errors than did good readers/spellers. In the second task, again the poor spellers, no matter what their reading skill, were not able to segment real and nonsense words as well as the good spellers. Based on these results Perin concluded that segmentation of words into phonemes may be achieved through knowledge of and skill with orthography.

Ehri and Wilce (1980) also found that the visual forms of words influenced segmentation tasks. Ehri and Wilce used 4th graders in a segmentation task where they had the children segment real and nonsense words spelled with extra letters (e.g. catch, own, comb; zitch, banyu; drowl). It was found that the visual forms of words influenced the segmentation task. The extra letters in the spellings resulted in the introduction of extra phonemes in the segmentation task. They concluded that "the acquisition of spellings may alter knowledge about pronunciations" and that phonemic awareness may be the result of learning to read and spell.

Both of these studies suggested that knowledge of spelling affects segmentation skills in particular and phonemic awareness in general. The subjects chosen for the present study do know how to read and write an alphabetic system -- namely English, so they should be able to successfully segment words into phonemes. However, the subjects are also illiterate in their mother tongue, that is, they do not know any orthographic norms for their Low German dialect, Plautdietsch (PD). The fact that these subjects know an alphabetic writing system means that they can segment, but the fact that there is no written form of their dialect means that there is no orthography to bias judgements in PD.

The work by Read (1986) on children's invented spelling describes how children with a limited knowledge of spelling conventions but with some knowledge of the alphabetic system (the idea of one letter for each sound) will produce spellings which suggest nonstandard segmentations. Read describes a series of experiments in which children were tested to see if they would omit preconsonantal nasals in their spellings. Of thirty-two first graders with 275 decidable spellings, 55% omitted the nasal letter(s) <n, m, ng> from their spellings in words like pump, plant and rink. For example, they spelled pump as <pop>. In a similar experiment using disyllabic words, Read also found the second graders spelled words like tinker, camper and crunches with nasals only 30% of the time. Read suggests that these creative spellings in which there is no separate symbol for a nasalized vowel are more phonetically accurate than the more abstract standard spellings which children learn later. Read also describes children's spellings of vowels plus /r/ as <r> 75% of the time in stressed and 60% in unstressed syllables. This, he ascribes to the fact that children are classifying retroflexed vowels as distinct from other vowels. It appears that, for various reasons, children do not readily segment vowels plus following resonants into separate segments but treat them as units. Based on Read's results with children's creative spellings, the prediction is made that adults unfamiliar with the spelling conventions of PD might also produce naive spellings which reflect segmentation into subsyllabic rather than strictly phoneme sized units.

Two tasks are under investigation in this chapter, a segmentation task and a spelling task. The segmentation task is based on Dow's (1981) segment count experiment where, after a brief training session on segmentation, subjects were asked to write down the number of "speech sounds" they heard in the word. Although there were some exceptions, overall she found a high correlation between the predicted phoneme count and the actual segment counts. One group of exceptions included words containing the /awr/ rime. Here she found orthographic interference in that subjects counted more segments in words like cower, bower and glower, than in words like sour, dour, and scour. The <-ower> spelling gives the perception of another syllable and hence an inflated count, whereas the <-our> spelling does not. Orthographic interference such as this is less likely in the segmentation task using PD speakers, as they have had little or no practice in reading or writing their dialect.

Dow (1987) conducted another segment counting experiment which included not only a phoneme counting task, but also syllable and subsyllabic unit counting tasks. She found significantly better performance on the syllable count task than on any of the other tasks. Surprising was the very low performance on the phoneme counting task (22% correct overall). Even more surprising was the poor performance on the phoneme count task by high school students (51% correct) who should be performing at the level of literate adults, leading Dow to doubt the universality of the phoneme as a natural unit.

There were some problems with Dow's 1981 and 1987 experiments however. As Dow and Derwing (1989) point out, in this type of task there is difficulty in knowing exactly what units subjects are counting. In the first experiment Dow had subjects write down the number of "speech sounds" in each word. In the second experiment, children put out a plastic counter for each unit and high school students gave a number response. While this method gives an overall count of "speech sounds", there was no way of verifying precisely which sounds were receiving counts or even where the precise segmentation points occurred.

In the present experiment an attempt was made to assess the exact units that were being counted. Subjects were asked to sound out the segments, and these attempts were recorded for later evaluation. While the subjects were vocalizing the individual speech sounds, they were also encouraged to keep track of the number by counting on their fingers. During the experiment, the investigator also kept a record of the individual segments and later compared these with the tape-recordings. In this way there would be no doubt as to how the subject had segmented words longer that three phonemes. The segmentation points were also clearer; for example, if a subject gave a count of 4 for a word like /plωmps/, it was possible to tell from the recordings whether the segmentation was /pl-ωm-p-s/, /p-l ω-m-ps/ or /p-l-ωm-ps/.

The second task was a spelling task which was conducted to further illuminate people's perceptions of sounds in words. The subjects taking part in this experiment have little opportunity to read or write PD, so any spellings they produce might reflect the spoken form of their dialect more readily than a standard orthography of English would reflect the pronunciation of an English dialect. In theory, if subjects group sounds together in a segmentation task, they will tend to use fewer graphemes when spelling that group of sounds.

Treiman (in press) hypothesized that there are correspondences between print and speech not necessarily based on phoneme-grapheme correspondences. Subsyllabic units are used in mapping speech to print by readers and spellers alike. Groups of phonemes which form units such as onset and rime may be associated with groups of graphemes. Treiman & Zukowski (1988) found when adult readers were asked to pronounce nonsense words like saip and vaid, where saip shares the <sai> of <said> and vaid shares the <aid> of <said>, that /ε/ pronunciations for vaid were more frequent than for saip. Even though an /ε/ pronunciation for <ai> is uncommon, the authors felt that any pronunciation of vaid like said suggests that there is a link between the rime /εd/ and the letter group <aid>. They conclude that people rely at least to some extent on subsyllabic units like rimes when reading.

Treiman (in press) also maintains that whereas the units of spoken and printed words are closely related, these units are not only single phonemes which corresponded to single graphemes, but can also be higher level units such as subsyllabic units which language users associate with multi-letter groups. Although there are many possibilities for interpretation if subjects use several letters to spell a single segment, one could be that subjects normally read using subsyllabic units and write using particular letter groups. The various possibilities for interpretation will be discussed in the spelling task section below.

In the present study three main questions were asked: 1) Is it possible for speakers of an unwritten dialect to successfully segment words into phonemes? If so, do their segmentations conform to any standard theoretical treatment? 2) If the speakers of an unwritten dialect do not readily segment words into phonemes, what kinds of units they do use, and are these units consistent with a hierarchical model of syllable structure? 3) When subjects who are unfamiliar with a written form of their language attempt to write it using the only writing system they know, i.e., the alphabet, will there be a one-to-one phoneme-grapheme correspondence or will there be evidence of other phonological units in their spelling?

In the following sections the method and analysis of both tasks will be outlined, then the results of the segmentation task will be discussed, followed by an examination of the spelling task and, finally, a general discussion of the results.

A. Method

1. Subjects

A group of bilinguals, who speak English and a Low German dialect, which they call Plautdietsch[18] (PD), were chosen for this experiment. After initial contact was made with the group, the subjects were recommended through word of mouth[19] and volunteers were selected a) if they had lived in the Swift Current, Saskatchewan, area most of their lives, b) if they still used PD regularly, and c) if they were literate in English. Twenty-five subjects, 12 male and 13 female, took part in the experiment. Three were between the ages of 15 and 19; two were between 20 and 39; eight were in the 40-49 age group; five were 50-59 and seven were 60-65. Note that all but five were over the age of 40.

2. Materials

With the aid of two native speakers[20] of PD, a list of 62 mono- and disyllabic PD words was prepared as shown in Appendix 1. The word list consisted of a variety of initial and final consonant clusters, with 48 (or 80%) of the words containing either pre- or postvocalic resonants and 21 (or 35%) containing diphthongs. The words ranged in length from 3 to 6 phonemes. Although, the

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[18] Pronounced /plautditš/.

[19] Some subjects came forward after the author participated in a radio broadcast about PD on the local radio station. Much interest in the study was generated in the area due to this broadcast, so that there was little difficulty obtaining suitable subjects for this study and subsequent experiments.

[20] These two speakers did not take part in any of the experiments.

majority of the words were monosyllabic, 7 words ended in a syllabic nasal or lateral.

The list was randomized and two presentation orders were prepared (Orders A and B). Then both orders of the word list were recorded by a female PD speaker (age 50) on a Sony TC K5511 stereo cassette player using a Sony Electret Condenser ECM-200 Microphone.

A training set of 7 English words was also prepared (See Table 1, p. 32). Five of these were monosyllabic and two were disyllabic. They ranged in length from 3 to 6 phonemes and were presented in the order of increasing number of phonemes. The training words contained none of the segment- and cluster-types to be tested in PD.

3. Procedure

The subjects were tested individually[21] in an office of the Swift Current Mennonite Brethren Church, a familiar setting to many of the participants. When they arrived they were randomly assigned a subject number and a word order. They were shown the tape recorders and asked if they would allow the interviewer to tape them. They were also assured that they would be informed when the tape recorder was turned on, that everything would be confidential and that they could stop any time they liked.

[21] Three couples were allowed to work together during the initial orientation where they could tell the stories to each other. During the spelling task they were tested at the same time but not allowed to discuss possible spellings.

a) Story-telling

First the subject was asked to tell the interviewer a story in PD using one of three following topics (cf. Labov, 1972):

i) their most embarrassing moment

ii) a time when they were really frightened

iii) something funny that happened to them

The tape recorder was turned on when the subject indicated that she was ready to begin. The only participation on the part of the interviewer during this segment was to nod, or say "Ja, ja". This portion of the task was used to familiarize the informant with the microphone and tape recorder and to get her thinking and speaking in PD.[22]

b) Segment Count Task

This task consisted of a training session and a test session. The subject was trained to count "speech sounds" as shown in Table 1. The subjects were invited to try to segment 'cat' and 'gives' with guidance from the interviewer. Once the interviewer was sure that the subject understood the task, two tape recorders were both turned on, one to play (a portable Sony cassette player) and one to record (using a Sony Electret Condenser ECM-200 Microphone and a Sony TC K5511 stereo cassette player). After each test word was given twice by the PD speaker on the pre-recorded tape, the tape recorder playing the presentation tape was turned off with a remote control switch. The other tape-recorder was left running

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[22] The interviewer only spoke to the subjects in English, although she indicated to all subjects that she understood PD and could even speak a little.

throughout the segment count task in order to have a record of the subject's pronunciation, segmentations and counts.

Table 1. Segment Count Task Training Session:

For each word presented, please tell me the number of speech sounds you think it contains. As a guide, I will give you several examples in English.

Word	**Number of Sounds**	**Details**
cat	3	/k/ sound as in 'kite' /æ/ sound as in 'ask' /t/ sound as in 'top'
debt	3	/d/ sound as in 'dog' /ɛ/ sound as in 'egg' /t/ sound as in 'top'
laugh	3	/l/ sound as in 'look' /æ/ sound as in 'ask' /f/ sound as in 'fun'
attack	4	/ʌ/ sound as in 'up' /t/ sound as in 'top' /æ/ sound as in 'ask' /k/ sound as in 'kite'
gives	4	/g/ sound as in 'got' /ɪ/ sound as in 'it' /v/ sound as in 'vat' /z/ sound as in 'zoo'

smack	4	/s/ sound as in 'sit' /m/ sound as in 'man' /æ/ sound as in 'ask' /k/ sound as in 'kite'
batman	6	/b/ sound as in 'boy' /æ/ sound as in 'ask' /t/ sound as in 'top' /m/ sound as in 'man' /æ/ sound as in 'ask' /n/ sound as in 'nut'

Note that only the number of sounds is required, not the full details given in the examples. If I ask you how many sounds in 'cat', you would first repeat the word /kæt/, then sound out the word /k/ /æ/ /t/,[23] count the speech sounds and then answer '3'. You can take as long as you like and you can use your fingers to help you keep track of the number of sounds. Are there any questions? I would like you to try one or two of these words before we begin the task.

Once the stimulus word was presented and the subject performed the task (of repeating the word, sounding out the speech sounds while counting the sounds on their fingers, and giving the number of sounds), then the presentation tape-recorder was turned on and a new stimulus word was given. Whenever the subject forgot any part of the task he was reminded what to do next. If, after the presentation of 3 stimuli, the subject seemed unclear of what the task was, then the training session was repeated and the task restarted. Only two subjects required retraining. At the completion of the task, subjects were encouraged to take a break

[23] The interviewer pronounced the voiceless stops as aspirated stops with as little vocalization after the stops as possible, i.e., an attempt was made to say /kʰ/ /æ/ /tʰ/ rather than /kᵊ/ /æ/ /tᵊ/.

and reminded that they were allowed to stop at any time. Every subject went on to complete the spelling task.

c) Spelling Task

The subjects were told that they would hear the same list of words again, in the same order, spoken by the same speaker. They were asked to write down the word using any combination of letters that were necessary, but they were asked not to use any unnecessary letters. They were reminded that we were interested in the speech sounds and they were cautioned to forget about any English or German spelling rules that they might know. Finally, they were told that there were no right or wrong answers, but that we were looking for a way to write PD so that anyone could read it with a local pronunciation.

4. Analysis

For each word a segment count was predicted, based on the number of phonemes in a standard traditional analysis (see Wiebe, 1983). All diphthongs were given a predicted count of two, including the long diphthongs /au; ai/ (VV), the in-gliding diphthongs /iʌ; eʌ; oʌ; uʌ/ (Vʌ) and the out-gliding diphthongs /ʌɷ, ʌɪ/ (ʌV).[24] The affricates /ts/, /tš/ and /dž/ were also counted as two units.[25] All

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[24] Mierau (1965) says that /au/ and /ai/ are vowel sequences but that /ʌɷ, ʌɪ/ are "units" (p. 6). Whereas Mierau refers to the ingliding diphthongs (Vʌ) as "vowel clusters" (p. 22), and Thiessen (1963, 1977c) treats them as vowel sequences, Moelleken (1967, 1972) maintains that vowels plus /ʌ/ are allophones of tense vowels. Due to the some conjecture about whether the different types of diphthongs were single units or sequences of vowels, an arbitrary decision was made to give all diphthongs the same count of two.

other consonants, including palatal consonants (C^y) were given one count.[26] The only purpose for doing so is for a standard of comparison.

On the basis of the taped responses (recorded during the segment count task), each subject's total segment count for each word was noted, entered into an MTS[27] computer file and an item analysis was run. No difference was found between the segment counts of those subjects given presentation order A or B, so the results were pooled. For each item or word, the predicted segment count was compared with the segment count most frequently given by the subjects. See Appendix 1 for the predicted segment count for each word (column 5).

The percentage of subjects who gave the "correct" response or the same segment count as predicted was calculated (column 6). The predicted responses were compared with the counts most frequently given by the subjects (the percentage of subjects responding with that particular count is in brackets in column 7). A comparison of the segment counts in columns 5 and 7 reveals that for 37% of the words the predicted segment count matched the most frequent subject segment count, but for 63% of the items the most frequent segment count given by subjects was lower than the predicted segment count. All but 8% of these had either a complex vowel or diphthong nucleus or a vowel followed by liquids or

__________(continued)

[25] The phonemic status of the affricates is controversial, but since both Goerzen (1972 and Mierau (1965) treat /ts/, /tš/ and /dž/ as stop-fricative sequences, it was decided to count them as bisegments.

[26] The treatment of palatals in the literature suggests that these are single phoneme units. Mierau (1965) writes that /k^y/ is "phonetically a unit rather than a sequence" (p. 19). Goerzen (1972) says that /k^y, g^y, n^y, l^y/ are phonemes not consonant plus glide seuences. Based on this evidence palatals were given a count of one.

[27] Michigan Terminal System, the mainframe operating system at the University of Alberta.

nasals. The final 8% contained /ts/ or /tš/, which could be considered two segments or disegmental affricates in this dialect.[28]

Table 2 below summarizes the percent correct segment counts for the 33 items with in-gliding and out-gliding diphthongs (ʌV, Vʌ), long diphthongs /ai, au/ (VV), or vowel plus the resonants /r/ (Vr);[29] /l, l^y/[30] (VL); /m, n, n^y, ŋ/[31] (VN).

Table 2. <u>Average Segment Counts</u>

Segment Type*	Average Percent "Correct" Responses	Range of Percent Correct Responses
VV (7)	3%	0% - 8%
ʌV (7)	10%	0% -32%
Vʌ (8)	23%	0% -84%
Vr (9)	43%	28% -56%
VL (9)	20%	0% -60%
VN (11)	29%	4% -72%

* Number of items containing this segment type is given in brackets.

[28] There could be other factors affecting the segment counts for these five words as three of them have prevocalic /l/'s and the other two have two syllables, the second of which is a syllabic /l/. These will be examined later in more detail.
[29] Upper case **R** is used to refer to the resonants /r, l, l^y, m, n, n^y, ŋ/. Lower case **r** is used to represent the phoneme /r/ which in PD is trilled in prevocalic position, is retroflexed in postvocalic position, may be flapped intervocalically and varies postvocalically and word-finally with /ʌ/. (See Wiebe, 1983, for a more complete discussion). A phonemic inventory for PD is provided as Appendix 3, with special attention paid to the variants of /l/ and /r/.
[30] Palatal or palatalized /l^y/ is not very common in PD and has a limited distribution (occurs only medially, Wiebe, 1983). In the set of stimuli it only occurs in one word /$mail^yk^y$/ 'milk'.
[31] The phoneme /n^y/ occurs infrequently in PD and, then, only intervocalically. There are two instances of /n^y/ in the stimulus items: /hen^yʌ/ and /ʌm^yn/.

The second column of Table 2 displays the average percent "correct" responses, or the percentage of subjects answers that matched the predicted segment count. An examination of these "correct" responses suggests that the subjects' segmentation of Vr more closely matches the predicted segmentation of items containing Vr (which is that V and r are separate segments) and that the subjects' segmentation of VV items does not match the predicted segmentation (which is that VV is two segments). However, if the range of percent correct responses in column 3 are compared with the averages in column 2, then it becomes clear that just looking at percent correct responses per item type may lead to erroneous conclusions, as the range for responses is quite large for all types except for VV. This is due to the fact that the words with the above types (VV, ʌV, Vʌ, Vr, VL, VN) may also contain various combinations of consonants (e.g., /haults/ has VVL, /gʸrʌm/ had ʌVN) and some consonants such as /ts/ (an affricate in High German) may be grouped together, all affecting the overall count. As noted earlier, this is one of the major drawbacks of an analysis of this type. Particularly in words with a complex syllable structure (i.e., syllables with consonant clusters, diphthongs, vowel plus resonants), it is not possible to tell which segments subjects have actually grouped together so that any conclusions may be purely speculative. This problem, which was anticipated, was alleviated by recording all sessions so that exact segmentations could be noted; this was also the purpose for including the spelling task.

5. Combined Segmentation and Spelling Task Analysis

The tapes were listened to again and the exact segmentation of each word was noted on the individual's spelling sheets. These segmentations were compared with the spelling and a more accurate representation of the subject's responses was achieved. For example, a full list of responses for /gәlaiz/ is given in Table 3 below.

Table 3. Average Segment Counts Example

SPELLING	NUMBER OF SEGMENTS	SEGMENTS	NUMBER OF RESPONSES	COMMENTS
grize	2	g rize	1	
cliz	3	cl i z	1	
glize	3	g li (i)ze	1	/ai/overlap
yleiz	3	y lei z	1	
gliese	3	g lie se	1	
glaz	4	g l a z	1	
ylaz	4	y l a z	1	
glez	4	g l e z	1	
gles	4	g l e s	1	
glise	4	g l i se	3	
glize	4	g l i ze	1	
jlize	4	j l i ze	1	
gleis	4	g l ei s	1	
gleiz	4	g l ei z	1	
yleiz	4	y l ei z	1	
gleize	4	g l ei ze	1	
glieze	4	g l ie ze	1	
gliese	4	g l ie se	1	
gelis	4	ge l i s	1	
julaz	4	ju l a z	1	
gelize	4	ge l i ze	1	
grdiz	4	g rd i z	1	
glize	4	g * li ze	1	* /ʌ/

The first column contains the spelling given by an individual subject. The next column contains the number of segments into which the particular subject divided the given word in the segmentation task. The subject's actual segmentation of the word using the subject's own spelling is shown in column 3, where the spaces indicate separate segments. The number of subjects using this response is given in column 4 and, finally, in column 5 are my comments about the response. If a subject segmented a word using the same sound in conjunction with the immediately preceding sound as well as with the immediately following sound, then this was indicated as an overlap in the last column of Table 3. For example, one subject segmented /g^{y}laiz/ as /g^{y}/ /lai/ /aiz/ in the segmentation task and spelled it as <glize> in the spelling task. Therefore, it is segmented as g li (i)ze and the repeated or "overlapping" sound is given in brackets. Any segments which were present in the segmentation task, but for which there seems to be no equivalent in the spelling task, are indicated by an asterisk in column 3, and the missing sound is given in column 5. Finally, this analysis and resulting charts were used to determine which sounds were treated as individual segments and which were grouped together as units.[32]

[32] However, it should be remembered that segmentation and spelling were done on separate passes and subjects might have changed their minds between the two tasks, so absolute consistency is not to be expected

B. Results and Discussion

1. Segmentation Task

The segmentation task results are divided into three sections. First, consonant clusters will be examined, then diphthongs, and finally, resonants will be discussed.

a) Consonant Clusters

(1) Initial Consonant Clusters

The initial consonant clusters under examination are 1) obstruents followed by a resonant (Cr where r=/r/, CN where N= nasals, CL where L=/l/); 2) a combination of a fricative plus a stop (FS); 3) a stop-fricative cluster (SF) and 4) the initial cluster /ts/ (ts). In the first column of Table 4 above the four different types are given. In the third and fourth columns are the number of times these types of consonant clusters were separated from each other (separation of #CC) rather than treated as a unit (cohesion of #CC).

Table 4. Initial Consonant Clusters:

TYPE OF #CC	EXAMPLE	SEPARATION OF #C\C
#Cr[33] (10)	præsn̩	91% ±7
#CL[34] (6)	blɪts	95% ±1
#CN[35] (4)	gnɪpl̩	97% ±3
#FS[36] (2)	šplet	71% ±24
#SF[37] (2)*	tvalv	92% ±6
#ts[38] (2)	tsɪpl̩	15% ±3

* does not include #ts
() indicates number of tokens for each type
± indicates standard deviation

In Table 4 it can be seen that subjects overwhelmingly preferred to separate the initial stop from a following resonant in initial consonant clusters (Cr, CN, CL). Therefore, pre-vocalic resonants are not highly"C-sticky" (Derwing et al., 1987) i.e., they do not stick to the initial consonant. There was a greater tendency to treat initial SF (stops plus fricatives excluding /ts/)[39] as units than initial FS , fricatives

[33] Initial consonant clusters containing a consonant plus /r/ were: /pr-, br-, tr-, dr-, gr- , g^yr-, fr-, vr-, šr-/.
[34] Initial clusters with laterals were: /pl-, bl-, gl-, g^yl-, šl-/
[35] Initial consonant clusters of the type #CN were: /gn-, g^ym-, k^yn-, g^yn/.
[36] The initial clusters in which fricatives were followed by stops were: /špl-, štr-/.
[37] The initial stop-fricative clusters were: /tv-, k^yv-/.
[38] In one stimulus item initial /ts/ occurred before /v/ and in another, prevocalically.
[39] Initial /ts/ was not included with SF as there was a noticeable difference on all tasks between subjects' treatment of other SFs and /ts/ both in initial and final position.

plus stops.[40] The cohesion score of initial /ts/ is quite different from those of the other initial obstruent clusters. As subjects rarely separated /ts/ in initial position, the sequence /ts/ thus appears to have the status of a single affricate segment in PD, as in High German.[41,42]

(2) Final Consonant Clusters

Final consonant clusters containing resonants (rC, LC, NC) as well as final obstruent clusters (SF, FS and /ts/) were examined. As can be seen in Table 5, the final clusters containing postvocalic resonants have scores similar to initial clusters containing prevocalic resonants (cf. Table 4).

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[40] There were only two stimulus items containing initial FS, /šplet/ and /štreml̩/. In both cases the initial FS preceded a prevocalic resonant. This may account for the lower scores for initial FS.

[41] There are two other possibilities for affricates in PD, /tš/ and /dž/. However, the stimuli contained no items with /dž/ as it is rare in initial position occurring only in borrowed words like /džɔmp/ 'jump'. Through an oversight, only one item with /tš/ in final position (none word initially) was included.

[42] Although no previous work has been done on affricates in PD, which makes their status dubious, the reason for suggesting that /ts/ is an affricate in PD is four-fold and based on phonetic, phonological, and distributional evidence as well as evidence from loan-words. First, phonetically all sequences of stop plus fricative, especially if they are homoganic like /t/ and /s/, can be viewed as affricates. Second, /ts/ contrasts with other phonemes, e.g., /tak/ 'tock' - /tsak/ 'peak' - /zak/ 'sack'. Third, /ts/ occurs initially, medially and finally, (/tsiz/ 'gulp'; /bitsl̩/ 'bee sting'; /mits/ 'kitty') and before /v/ like other single units (e.g., /tsvak^{y}/ 'purpose'; /tve/ 'two'; /dvol/ 'rush'; /kvak/ 'quack'). Fourth, when PD speakers borrow words from other languages beginning with /s/, they either voice the /s/ to /z/ ('sack' → /zak/) as /s/ does not occur word-initially or use the voiceless unit /ts/ which can occur initially ('size' → /tsaiz/).

Table 5. Final Consonant Clusters

TYPE OF CC#	EXAMPLE	SEPARATION OF C\C#
rC#[43] (5)	hɔrx	99% ±3
LC#[44] (4)	kɔlt	100% ±0
NC#[45] (3)	kʸɪnt	93% ±2
FS#[46] (5)	mɪʌšt	74% ±15
SF#[47] (3)	lɷtš	61% ±13
ts#[48] (7)	blɪts	41% ±13

() indicates number of tokens for each type
± indicates standard deviation

Final obstruent clusters are more likely to be treated as a unit than final clusters containing resonants. Whereas a final consonant in SF and FS clusters was separated from the preceding consonant 68% of the time (and /ts/ only 41%), final consonants were almost always (97%) separated from postvocalic resonants, that is, postvocalic resonants were also not C-sticky. So, both initially and finally, obstruent clusters were more cohesive than those clusters with pre- and postvocalic resonants.

Final /ts/ was more often treated as a unit than the other final obstruent clusters (FS and SF). However, /ts/ was less cohesive in final than in initial position. This implies that, for some speakers, final /ts/ does not have the same

[43] Final rC clusters were /-rp, -rš, -rž, -rç, -rx/.
[44] Final clusters of the type LC# were /-lt, -lf, -lv, -lʸkʸ/.
[45] Final CCs containing nasals were /-nt, -nz, -mz/.
[46] Final FS# clusters were /-st, -št, -çt/.
[47] The SF# cluster in word-final position were /-ps, -tš, -kš/
[48] Final /ts/ occurred postvocalically in four of the stimuli and after /l/ in two.

status that it has in initial position. Ewen (1982), using a Dependency Phonology framework, offers an explanation for the difference between initial and final /ts/ in English and German. He maintains that /ts/ and other affricates have a reversed dependency structure where the more sonorant element or fricative is dependent on the less sonorant element or stop and this should hold for initial and final position. In German, initial and final /ts/ are identical and behave as units in both positions. However, initial and final /ts/ in English are not identical. Final /ts/ is a mirror-image of initial /st/ where /t/ is simultaneously dependent on both /s/ and the vowel. Moreover, according to Ewen, final /ts/ in English has the length of a normal cluster whereas the affricate /ts/ in German has the length of a single segment. This might also explain why PD subjects more easily separate /ts/ in final position and more readily treat initial /ts/ as a unit. Even though PD is a Low German dialect, through years of contact with English it has been influenced by English, including its phonology (see Wiebe, 1987). Thus, PD speakers might have been influenced by English phonology for final /ts/, which occurs both in English and PD, but not for initial /ts/, which does not occur in English.

Another reason for the difference in cohesion of initial and final /ts/ might be that some fricative-stop and stop-fricative clusters arise in both English and PD due to morphological processes. Therefore, subjects would have more practice in separating consonants in final position than in initial position by the mere fact of deleting or adding inflectional morphemes in everyday use. Whatever the reason for this difference in cohesiveness between initial and final /ts/, more work needs to be done in this area.

(3) Word-Final Syllabic Consonants

The stimuli included 8 items ending in a syllabic consonant: 4 ended in syllabic /l/ and 4 in syllabic /n/.[49,50]

Table 6. Syilabic Consonants

TYPE OF CC#	EXAMPLE	SEPARATION OF C\C#
CL#[51] (4)	bitsl̩	82% ±9
CN#[52] (4)	dræšn̩	80% ±9

() indicates number of tokens for each type
± indicates standard deviation

The results of the segmentation task suggest that for some subjects, syllabic consonants act as a unit at least some of the time. It is interesting if we compare initial and final clusters containing resonants (cf. Table 4, p. 41) Whereas final N and L are 19% C-sticky, N and L are only 3% C-sticky in initial clusters. It seems that an initial consonant plus resonant is less cohesive than a final consonant plus resonant. This is a surprising result since in the latter case resonants are syllabic.

49 In his list of final consonant clusters, Goerzen (1972) includes /CN/ and /CL/. However, he stipulates that the final resonants /n,m,l/ are syllabic in these clusters.
50 There are no word-final syllabic /r/s in PD; where cognates in other Germanic languages would have syllabic /r/ as in English 'farmer', PD has /ʌ/ as in /fɔrmʌ/.
51 Word-final syllabic /l/ occurred in clusters with /p, ts, m/.
52 Syllabic nasals following /k, š, s, nʸ/ were included in the stimuli.

(4) Palatal Consonants

Some of the palatal consonants in PD[53] were absolutely cohesive in initial and final positions but had a tendency to separate word medially.

Table 7. Palatal Consonants

WORD POSITION	EXAMPLE	SEPARATION
Initial (13)	k^yast	1% ±3
Final (3)	tsveʌk^y	0% ±0
Medial Stop (1)	jɷ$n^y k^y$ʌ	24%
Medial Nasal (2)	hɛn^yʌ	62% ±8

() indicates number of tokens for each type
± indicates standard deviation

A difference was also noted in the relative cohesion of medial stops and nasals. In Table 7, the numbers suggest that /n^y/ is much more likely to be separated by speakers of PD than medial stops. However, there were only two words containing /n^y/ and in both of these the palatal nasal occurred intervocalically (V__V). In each case the tendency was for the palatal element to stick to the following vowel and to be separate from the nasal. There was only one stimulus item containing the voiceless palatal stop, /k^y/, in medial position and this was in the environment C__V. Perhaps, intervocalically, /k^y/, would also be less cohesive, but due to lack of data it is hard to tell. At any rate, the internal cohesion of [+stop, +palatal] consonants in PD, depends on the environment.

[53] The palatal consonants in question are /k^y/, /g^y/, /n^y/ and /l^y/.

b) Diphthongs

The stimuli contained three types of PD diphthongs (see Table 8 below): long diphthongs, /au/ and /ai/ (VV); short outgliding diphthongs, /ʌɪ/ and /ʌω/ (ʌV) ; and ingliding diphthongs, /iʌ/, /eʌ/, /uʌ/, /oʌ/ (Vʌ).

Table 8. Diphthongs

TYPE	EXAMPLE	SEPARATION
VV (5)	frauts	3% ±4
ʌV (8)	fʌɪt	1% ±1
Vʌ (8)	vuʌt	33% ±27

() indicates number of tokens for each type
± indicates standard deviation

The ingliding diphthongs (Vʌ), which were separated 33% of the time, seem to form a less cohesive unit than the other diphthongs (only about 2% separation). This suggests that the outgliding diphthongs, both long (VV) and short (ʌV), are generally inseparable units, while the ingliding diphthongs (Vʌ) are sometimes treated as units and sometimes treated as a sequence of two vowels.[54]

In Table 9 below it can be seen that the type of syllable, closed (CVʌC# or CVʌ CC#) or open (CVʌ#), as well as the number of consonants following ingliding diphthongs can have an effect on the cohesiveness of Vʌ.

[54] Perhaps this could be compared with English spelling. There are some in-glides, such as the vowel of bit, which is often [ɪ] plus schaw, which are nevertheless always spelled with just one letter.

Table 9. Effects of Final Consonant Clusters on Ingliding Diphthongs

TYPE	EXAMPLE	SEPARATION
CVʌCC# (4)	miʌšt	16% ±9
CVʌC# (3)	fiʌt	45% ±8
CVʌ# (1)	fuʌ	84%

() indicates number of tokens for each type
± indicates standard deviation

Thus, the greater the number of consonants following Vʌ, the more cohesive the ingliding diphthongs become. Various explanations offer themselves. The second part of the ingliding diphthong, the central vowel /ʌ/, may be more noticeable to the subject in word final position and due to this increased saliency is easier to separate. The number of phonemes in a stimulus item could also be affecting the subject's segmentation ability. Whatever the reason, the embedding of the diphthong in a complex syllable structure affects the diphthong's cohesiveness.[55]

c) Vowels Plus Resonants

In this section both prevocalic and postvocalic resonants will be examined and the effects of syllable structure complexity will also be discussed.

(1) Prevocalic Resonants

In the examination of initial consonant clusters, it was found that prevocalic resonants were not very C-sticky (only about [illegible]). The question, then, is if they do

[55] See the discussions about the increasing cohesiveness of resonants in "embedded" positions on pages 50 to 52.

not adhere to the initial consonant(s), do they tend to join with the following vowel, i.e., are they V-sticky? The answer can be seen in the following table.

Table 10. Prevocalic Resonants:

TYPE	EXAMPLE	VOWEL-RESONANT SEPARATION
rV (12)	grʌɔt	85% ±12
LV (8)	glɔts	86% ±9
NV (7)	gnɔr	84% ±11

() indicates number of tokens for each type
± indicates standard deviation

The prevocalic resonants do have a greater tendency to stick to the following vowel (approximately 16%) than to the initial consonants (approximately 5%; see Table 4), but the strong preference is to treat prevocalic resonants as separate units or segments.

The structure of the syllable in which the resonant is found has an effect on the vowel stickiness of the resonant. In Table 11 below, it appears that there is a gradation of stickiness of the prevocalic resonant to the following vowel, depending on how many, if any, consonants precede the resonant.

Table 11. Effects of Consonant Clusters on Prevocalic Resonants' Vowel Stickiness.

TYPE		EXAMPLE	VOWEL-RESONANT SEPARATION
#CCrV	(1)	štreml̩	56%
#CrV	(11)	šrɛt	85% ±7
#rV	(1)	rɛlps	100%
#CCLV	(1)	šplet	74%
#CLV	(6)	šlüt	86% ±8
#LV	(1)	lɷtš	100%
#CNV	(5)	k^{y}ned	81% ±9
#NV	(2)	nækš	94% ±3

() indicates number of tokens for each type
± indicates standard deviation

Prevocalic /r/ has the greatest tendency to adhere to the vowel when preceded by two consonants, is clearly less V-sticky when preceded by only one vowel, and exhibits no vowel stickiness when in initial position. Prevocalic /l/ and /n/ seem to follow the same trend; however, as there are no instances of /n/ preceded by two consonants, /n/ does not entirely fit the pattern. Nevertheless, the conclusion must be the same, that is, the more sounds that precede the prevocalic resonant, the more likely the resonant is to be treated as a unit with the vowel. The reason why "embeddedness" affects vowel-resonant cohesion is not entirely clear other than that subjects could just be avoiding having a long string of segments in the onset. On the other hand, the explanation could be that in words with complex onsets subjects may ignore the most internal sounds with resultant chunking of resonants and vowels. Treiman (in press) offers a similar explanation for omissions in children's spellings.

(2) Postvocalic Resonants

Postvocalic resonants, which as we saw above (Table 5, p. 43) almost never stick to the following consonant, have an even greater tendency to stick to the vowel than prevocalic resonants. Whereas postvocalic liquids and nasals were moderately V-sticky (see Table 12 below), postvocalic /r/ was stuck to the vowel more often than it was separated.

Table 12. Postvocalic Resonants

TYPE	EXAMPLE	VOWEL-RESONANT SEPARATION
Vr (9)	darp	42% ±12
VL (9)	kɔlt	61% ±20
VN (10)	pɔnt	64% ±16

() indicates number of tokens for each type
± indicates standard deviation

Again, the structure of the syllable in which the postvocalic resonant is embedded has an effect on its V-stickiness, as indicated in Table 13.

Table 13. Effects of Final Consonant Clusters on Postvocalic Resonants Vowel Stickiness.

TYPE	EXAMPLE	VOWEL-RESONANT SEPARATION
VrCC# (1)	kʸaršt	22%
VrC# (5)	kʸɔrš	44% ±6
Vr# (1)	gʸnɔr	72%
VNCC# (1)	hɛŋkst	58%
VNC# (5)	glOmz	72% ±10
VN# (1)	gʸrʌm	80%
VLCC# (4)	rɛlps	58% ±25
VLC#[56] (5)	tvalv	61% ±17

() indicates number of tokens for each type
± indicates standard deviation

When postvocalic /r/ is followed by two consonants it is very V-sticky, less so if followed by one consonant but still more V-sticky than not, and even less so when in final position. Postvocalic nasals and liquids, exhibit the same trend, but they are always less than 50% V-sticky. This is the same tendency noted for prevocalic resonants (see p. 50 above). It appears that the more embedded a resonant is, the greater tendency that resonant has to form a unit with the vowel, and this holds for both prevocalic and postvocalic resonants.

It was noted earlier that ingliding diphthongs also exhibit this tendency to be more cohesive the more embedded they are in a complex syllable (see p. 48). In

[56] It is possible to have /l/ in final position in PD, but the stimuli did not contain a monosyllabic word of this type.

this case, ingliding diphthongs (Vʌ) seem to behave more like vowels plus resonants than like the other two types of diphthongs (both outgliding). Interestingly, Vʌ and Vr have similar stickiness values (67% and 62% respectively). It seems that VV and ʌV (outgliding diphthongs) form one type of nucleus, Vʌ and Vr a second type, and VL and VN a third type. Of the three types, the first (VV and ʌV) forms the most cohesive unit (98% cohesiveness) while the third type (VL and VN) was most often separated (27% cohesiveness). The second type (Vʌ and Vr) was separated approximately one-third of the time and treated as a unit two-thirds of the time. Thus, there is a gradation to the bonding of vowel-resonant clusters and vowel-vowel clusters (diphthongs) in PD. Derwing et al. (1987) also noted a similar "gradualness" in the results of their experiment on the structure of the vowel nucleus. This led them to suggest a "scalar bonding model" for the English syllable rather than a hierarchical model. Given the results here, this type of model also seems more suitable for PD.

2. Spelling Task

In the analysis for the Segmentation Task each subject's segmentation of a test word was paired with her spelling of that particular word. In this way it was possible to see if there was a one-to-one grapheme-phoneme correspondence.

If a subject used one grapheme for one segment or two graphemes for two segments and so on, then it was assumed that these segments were non-complex units for that subject. If, however, a subject used two graphemes for one segment, then several interpretation possibilities arise. First, the subject is maybe using a digraph to represent a single sound; for example, /š/ may be written <sh> as in English. Second, if the sound is present in neither English nor German, the subject must invent some novel way in which to represent this segment, e.g., /k^y/ spelled <ky> or <kj>. The subject may believe that there is only one segment but this segment is more complex than some others and wants to represent this in the spelling. Again, the voiceless palatal stop can serve as an example. The subject knows that this sound is like the voiceless velar stop /k/ so uses the letter <k> which is the standard way to represent /k/ in both English and German orthography. However, the subject also knows that /k^y/ is different from /k/ in that it is palatalized or somehow like /y/ (which may be written <y> in English or <j> in German). Third, the subject may have felt there was only one sound in the segmentation task, but on further deliberation during the spelling task may realize that there is, in actual fact, more than one segment, and reflects this reanalysis in the spelling. If, for instance, a subject, who has never written PD before, is required to write a word like /k^{y}ɔrš/, that subject will have to sound out the word, much like in the segmentation task. But this time, when the focus is on writing, the subject has to segment /k^{y}ɔrš/ and, using her knowledge of English and/or

German orthography, find a corresponding grapheme (or sequence) to represent the segment /k^y/. During this process, the subject may reanalyze /k^y/ into two sounds, /k/ and /y/ and, therefore, use two graphemes to represent these sounds. Whatever strategies subjects use to write PD words they must use a combination of top-down processing to break the word down into successively smaller units (as suggested above) and bottom-up processing as they reconstruct the word letter by letter (Bryant and Bradley, 1983) or letter group by letter group (Treiman and Zukowski, 1988).

a) Pre- and Postvocalic Resonants

In the segmentation task, subjects sometimes included prevocalic resonants with the vowel (16%), but more often postvocalic resonants formed a unit with the vowel (62% for Vr, 38% for VN and VL). See column 2 in Tables 14 and 15 below. Yet, even though a vowel-resonant combination was treated as a unit in the segmentation task, these same units were spelled with two letters in the writing task (see column 3). For example, Table 15 shows that /r/ formed a unit with the vowel (was V-sticky) in the segmentation task 62% of the time, but of this 62% only 2% spelled this segment with one letter (e.g. /ar/ spelled <r>; /ɛl/ spelled <a>[57]; /lü/ spelled <u>).

[57] Yes <a>, this is not a typo.

Table 14. Representations of Vowels and Prevocalic Resonants in the Spelling Task

Type	V-sticky	1 segment spelled with	
		2 letters	1 letter
rV (9)	18%	99% ±4	1%
LV (7)	16%	99% ±10	1%
NV (5)	15%	100% ±0	0%

() indicates number of tokens for each type
± indicates standard deviation

Table 15. Representations of Vowels and Postvocalic Resonants in the Spelling Task

Type	V-sticky	1 segment spelled with	
		2 letters	1 letter
Vr (9)	62%	95% ±6	2%
VL (7)	37%	98% ±3	2%
VN (5)	38%	98% ±5	2%

() indicates number of tokens for each type
± indicates standard deviation

In Standard English and German orthography, vowels plus nasals and liquids are written with two characters; one symbol represents the vowel and the other represents the consonant. Even though subjects chunked vowels plus postvocalic resonants an average of 44% of the time in a segmentation task, they almost always adopted the spelling conventions of English or German to represent this unit in a spelling task. Ninety-six percent of the subjects who treated Vr, VN and VL as a single segment, went on to use two letters for these segments and the two letters were generally a vowel plus the usual grapheme for the corresponding phoneme, e.g., subjects used vowels plus <l> for the segment /l/.

There could be an argument that the subjects were using a digraph strategy to represent (what for them is) an inseparable single segment, (cf. English <th>). However, as different types of processing are involved in the segmentation and spelling tasks, during the written portion the subjects may have been able to further analyze words containing postvocalic resonants into smaller units, so that in the spelling task, two letters represent two segments. It is not possible to tell which is the case but there is, at least, an indication from the spelling that subjects are aware that the segment has vocalic as well as liquid or nasal properties.

Arguably, under either interpretation, during the segmentation task the nucleus shares the features [+sonorant,+syllabic] for these subjects. During the spelling task, it seems that these same subjects may have become aware that the first part of the nucleus has the feature [+syllabic] which they represent with the letters <i, e, a, u, o>, and another segment with the feature [-syllabic, +sonorant] (Selkirk, 1982), which they represent with the letters <r, n, m, l> and the digraph <ng>.

Even though subjects usually spelled vowel-resonant units (units treated as single segments in the segmentation task) with two letters, there were a few interesting exceptions. Prevocalic /r/ plus vowel, which was segmented as a single unit, was spelled as <drV> in <ye**dri**et> /gʸrʌɪt/ 'Greta', <**gdrous**> /grʌɔs/ 'great', <sch**dr**icht> /šrɛt/ 'step', and as <rlV> also in <s**rla**t> /šrɛt/. These subjects may have been attempting to differentiate the trilled /r/ which occurs prevocalically in PD from the postvocalic retroflexed or continuant /r/ (see footnote p. 36). In one case a single vowel was used to spell rV which had been treated as a cohesive unit in the segmentation task: <staml> /štrɛml̩/ 'strip'. A single vowel was also used for a cohesive Vr in three words: <dape> /darp/ 'village'; <hove> /harx/ 'listen'; and <yach>, <kosh>, <chosh> (3 subjects), <ckush>, <chush>, <quach> for /kʸOrš/ 'cherry'. This supports the claim that certain subjects have difficulty separating postvocalic /r/ from a vowel, so they chose a vowel to represent it in the spelling.

Cohesive pre- and postvocalic /l/ plus vowel were occasionally represented by one to two vowels and even syllabic /l/ was written with a vowel by one speaker: <stramo>[58] for /štrɛml̩/ 'strip'. Twice a chunked vowel-nasal combination was written with a single letter, once with a vowel (<hekz> /hɛŋkst/ 'stallion') and once with a nasal (<glmz> /glɔmz/ 'cottage cheese'). Again this would suggest that for some subjects vowels plus resonants form a cohesive unit. Though a minority strategy, 11% of subjects' overall responses indicate a single spelling for cohesive Vr and rV which still surpasses the 5% single spelling of cohesive VL and LV or the 1% for VN and NV. This result would seem to support the results of the segmentation task which found that there is a gradation of V-stickiness for the liquids and nasals: r>L,N.

b) Diphthongs

Similar spelling strategies seem to have been employed for all types of diphthongs. If we look at the final column in Table 16 we can see that an average of 56% of those subjects who unitized the diphthongs in the segmentation task, spelled those diphthongs with one letter, a clear indication that these subjects are treating diphthongs as indivisible units.

[58] Compare Old High German *strimo* 'strip, stripe'.

Table 16. Representations of Diphthongs in the Spelling Task

Type	Cohesiveness	1 segment spelled with	
		2 letters	1 letter
ʌV (8)	99%	41% ±16	59%
VV (5)	97%	44% ±21	56%
Vʌ (8)	67%	50% ±17	50%

() indicates number of tokens for each type
± indicates standard deviation

The rest of the subjects who segmented diphthongs as one unit used two or more letters to represent that unit. However, again there is no way of knowing if, for example, two letters are being utilized as a digraph or if they represent the reanalysis of the unit into 2 sounds during the spelling task.

Even though subjects used digraphs to represent diphthongs, these did not always correspond to the conventional spelling of diphthongs in either English or standard German.[59] All variations in spelling of diphthongs (including single graphemes) are listed in Table 17.

[59] Note, the ingliding diphthongs (Vʌ) have no equivalents in either language.

Table 17. Spellings of Diphthongs

Types of Diphthongs		Single	Digraphs	Trigraphs (or more)
Vʌ	/iʌ/ (50)*	e (8), ü (2)	ea (11), ie (9), ei (7), ey (2), ee, ia, eu**	eia, eae, eie, eea, ier, egh
	/eʌ/ (38)	a (18), e (6), ä	ai (4), ae (2), är (2), ar (2), ui, ee, av	
	/öʌ/ (25)	u (8), o, ö, ü	ua (3), ou (2), ue (2), ur, oe	ewa, ugh
	/üʌ/ (25)	u (15), o	ue (2), ua, uo, ou, oe, ur	
	/uʌ/ (50)	u (3), o	ua (9), oo (5), ou (5), oa (5), ue (4), oe, oh, üa, uo, ur, or, ör	oua (2), oya, oah, oha, ohe, uoa, ooh, ueh, uah, ewa, uer, oaha
ʌV	/ʌı/ (138)	e (37), i (29), u (19), ä	ei (16), ie (11), ee (6), ae (3), ea (2), ou (2), ue (2), eu, ai, yu	eou, eag, ieugh (2)
	/ʌo/ (50)	u (13), o (12), ü, a	ou (15), ow (3), au, oa, oe, oo	
VV	/ai/ (75)	i (20), a (9), e (4), u (3)	ei (7), ae, ai,	
	/au/ (50)	a (20), o (18), u (7)	au (19), ou (15), ow (11), aw (4), uo	

* Numbers in brackets represent total subject responses
**Assume a count of one for spellings without a number.

In Table 17 there is evidence of various strategies employed to represent PD diphthongs in written form. Some subjects seemed to have used a type of letter-name spelling (see column 3). Subjects who spelled /iʌ/ with <e>, /eʌ/ with <a>, /ʌı/ with <e> and /ʌo/ with <o> all seemed to have focused on the non-central portion of the diphthong (which arelonger and therefore more may besalient) and represented it with the closest sounding letter-name. Similarly the <i> spelling for /ai/ and /ʌɪ/ indicates a letter-name spelling for the whole diphthong. As all subjects are familiar with the spelling conventions of English, the many and varied digraph spellings (column 4) could be indicative of an attempt to represent the difference between PD and English diphthongs. The trigraphs column (column 5 in Table 17) suggests a careful sounding-out on the part of the subjects during the spelling task.

c) Consonant Clusters

In Tables 18 and 19 below it can be seen that subjects generally spelled the fricative-stop clusters (FS) and the stop-fricative clusters (SF) with two letters, even though they may have unitized these clusters in the segmentation task. It can also be seen that subjects who treated obstruent clusters as a unit in the oral task were more likely to spell these clusters with one letter in word-initial than word-final position.

Table 18. Representations of Final Consonant Clusters in the Spelling Task

Type	Cohesion of CC#	1 segment spelled with	
		2 letters	1 letter
FS (5)	26%	95% ± 7	5%
SF (3)	39%	87% ±12	13%
/ts/ (7)	59%	73% ±19	27%

Table 19. Representations of Initial Consonant Clusters in the Spelling Task

Type	Cohesion of #CC	1 segment spelled with	
		2 letters	1 letter
FS (n=2)	29%	87% ±18	13%
SF (n=2)	8%	83% ±24	17%
/ts/(n=2)	85%	8% ±12	92%

() indicates number of tokens for each type
± indicates standard deviation

The affricate /ts/, which was most often unitized in both positions (see column 2), was also most often spelled with a single letter, especially word-initially (see column 4). The affricate /ts/ does not occur word-initially in English, so some subjects who are familiar with High German adopted the standard High German spelling <z> for word initial /ts/. The rest (53%) used either <t> or <s>. So, it would seem that some subjects were using a single grapheme for a single segment.

That /ts/ was more often spelled with two letters word-finally is not surprising, as this sequence appears word-finally in both English and High German and is spelled with two letters in both (English <ts> and High German <tz>), when not preceded by a consonant. As all subjects are literate in English one would expect them to use two letters when writing this cluster. What is unexpected is that 27% of the subjects who treated this affricate as unsegmentable in final position, spelled it with only one letter, a non-standard spelling in English, (c.f., cats or Katz). This is good supporting evidence of a monosegmental treatment.

The affricate /tš/ was only tested word-finally in one stimulus item, /lωtš/. No subjects used one letter, as the standard English spelling is <ch> or <tch> and

German is <tsch>. Those who unitized /tš/ in the sounding-out task and used the digraph <ch> (38%) in the writing ing task may indeed be treating /tš/ as an indivisible unit. The other 62% who used <tch> may be using a trigraph for a single segment, or may be aware that the affricate /tš/ and the stop /t/ have some features in common.

There were three instances where subjects who had segmented the affricate /ts/ into two units spelled it with one letter (as shown in Table 20 below).

Table 20. Spelling of Final /ts/.

Item	Segmentation	Spelling
/pɛlts/	p ɛ l t s	<pelz>
/hawlts/	h aw l t s	<howls>
/jelts/	j e l t s	<yailz>

In each of these instances /ts/ was preceded by /l/ which may have affected subjects' spelling. As suggested above, subjects' interpretation of the affricate may be task dependent. On the other hand, as <z> is used in the High German spelling, for two of the words, at least, the subjects may have used a single grapheme to represent two phonemes, much as the grapheme <x> is used to represent /ks/ in English.

d) Palatal Consonants

Most subjects treated the palatal consonants as one segment in word-initial and word-final position, (see Table 21, column 2).

Table 21. Representations of Palatal Stops in the Spelling Task

Type	Cohesiveness of C^y	1 segment spelled with	
		2 letters	1 letter
Initial (12)	99%	38% ±24	62%
Final (4)	100%	45% ±12	55%
Medial Stop (1)	76%	56%	40% [60]
Nasal (2)	38%	86% ±4	14%

() indicates number of tokens for each type
± indicates standard deviation

Those who treated initial and final /k^y, g^y/ as single segments also used a single letter between one-half and two-thirds of the time to represent these segments in the written task. Palatal stops which were less often treated as cohesive units in medial position than in initial and final positions were less often spelled with a single letter. Thus, it appears that in both tasks medial palatals are easier to separate than initial and final palatals. The various spellings of initial, medial, and final /k^y, g^y/are itemized in Table 22, and the spellings of /n^y/ in Table 23 below.

[60] One subject represented this sound by a question mark, which accounts for the remaining 4%.

Table 22. Spellings of the Palatal Stops

Types of Spellings	Examples			Initial /k^{y}/ (150)[61]	Initial /g^{y}/ (149)[62]	Medial /k^{y}/ (25)	Final /k^{y}/ (67)[63]
Single Consonants							
<k>	<kosh>	/k^{y}ɔrš/	'cherry'	68	3	6	36
<g>	<gnrr>	/g^{y}nɔr/	'grumble'		90	2	
<y>	<ylaz>	/g^{y}layz/	'track'	4	9	1	
<j>	<jrite>	/g^{y}rʌɪt/	'Gretta'		3	1	
<c>	<cint>	/k^{y}ɪnt/	'child'	5	1		1
<t>	<tint>	/k^{y}ɪnt/	child'	1			
<q>	<qast>	/k^{y}ast/	'wedding'	9			
<h>	<kureeh>	/gṛk^{y}/	'pickle'				1
C + /h/							
<ch>	<chast>	/k^{y}ast/	'wedding'	32		4	13
<kh>	<kharsht>	/k^{y}aršt/	'crust'	4			
<gh>	<ghren>	/g^{y}rʌɪn/	'green'		1		

[61] These are absolute numbers. The numbers in brackets represent the total number of responses per type. The other numbers (those not in brackets) represent the actual number of spellings per grapheme type for the palatal consonants in word initial, medial and final positions.
[62] One subject did not respond to /g^{y}müz/ 'vegetables' in the spelling task.
[63] Only 17 subjects responded to /tsveʌk^{y}/ 'purpose' in the segmentation task (they did not know the word so did not want to segment it). Only these 17 subjects were given /tsveʌk^{y}/ in the spelling task.

Types of Spellings	Examples			Initial /kʸ/ (150)	Initial /gʸ/ (149)	Medial /kʸ/ (25)	Final /kʸ/ (67)
palatal glide + V							
<yV>	<yaren>	/gʸrʌɪn/	'green'	2	8		
<jV>	<jiminte>	/gʸmʌɪnt/	'group'		5		
stop + vowel							
<kV>	<kewack>	/kʸveʌkʸ/	'quack grass'	2	1		3
<gV>	<gurine>	/gʸrʌɪn/	'green'		27		
C + palatal glide							
<ky>	<kyint>	/kʸɪnt/	'child'	1		3	
<tj>	<tjnade>	/kʸned/	'knead'	6		1	2 [64]
<cj>	<cjast>	/kʸast/	'wedding'	1			
<cy>	<cyast>	/kʸast/	'wedding'	1			
<kj>	<yukje>	/jɷŋkʸʌ/	'youngster'			2	
Others							
CC <kg>	<kgast>	/kʸast/	'wedding'	1		2	
<ck>	<ckush>	/kʸɔrš/	'cherry'	1			8
<kt>	<yunkti>	/jɷŋkʸʌ/	'youngster'			2	
C(C)V <ci>	<cinade>	//kʸned/	'knead'	1			
<qi>	<qivak>	/kʸveʌkʸ/	'quack grass'	1			
<chu>	<chunade>	/kʸned/	'knead'	7			
<qu>	<quint>	/kʸɪnt/	'child'	2			
CCC <cht>	<gurcht>	/gɽkʸ/	'pickle'				3
? [65]	<young?>	/jɷŋkʸʌ/	'youngster'	1	1	1	

As subjects tried to cope with spelling a segment which has no equivalents in either English or High German, a variety of graphemes and grapheme

[64] One of the spellings of final /kʸ/ was palatal glide followed by C: <jt>.
[65] Subjects were told that they could use a question mark if they were not sure of how to represent a particular sound.

combinations emerged (see column 1, Table 22). The single consonant spelling reflects the stop quality (<k, g, c, t, q>), the palatal quality (<y, j>) or the aspiration of the voiceless stop (<h>). This is evidence that subjects focused on one aspect of the sound and found the closest equivalent in an attempt to represent a single sound by a single grapheme. Consonants followed by /h/ or by palatal glides represent efforts to denote that these segments are like the stops /k/ and /g/ but with something added. The <ch> spelling, which was the most common two-consonant spelling for /k^y/, may either indicate the similarity between aspirated /k^y/ and /tš/ for many speakers[66]. The palatal glide plus vowel and the stop plus vowel spellings are unlikely to be digraphs (two letters to represent one sound); rather they are more likely to be the result of careful "sounding out" or subvocalizations while spelling, so that an extra sound (a vowel) is introduced. This phenomenon has also been observed in early spelling attempts by children (Ehri, 1987).

Similar spelling strategies were observed for the palatal nasal as shown in Table 23 below. The spelling of the palatal nasal is of interest as this sound is rare in both English and High German. Again, the spellings containing <j> and <y> suggest that many subjects are aware of the palatal quality of /n^y/. Of course, there is no way of knowing from the spelling whether subjects have further analyzed /n^y/ into nasal plus palatal or are using a digraph to represent one sound. The most popular spelling, <ng>, is probably a digraph spelling for /n^y/ much as it is for /ŋ/ both in German and English. It is not clear if those who used this digraph are

[66] For speakers who knew High German another possibility is that the <ch> spelling may reflect the High German spelling for /x/ and /ç/, sounds which are also similar to /k^y/

unaware that /n^y/ differs from /ŋ/ or if they are just using the English spelling for the sound closest to /n^y/.

Table 23. Spellings of the Palatal Nasal

Types of Spellings	Examples			Responses* (50)
Single Consonants				
<n>	<hena>	/hɛn^{y}ʌ/	'behind'	5
<g>	<ugen>	/ʌɪn^{y}n̩/	'under'	2
<ng>	<oungen>	/ʌɪn^{y}n̩/	'under'	19
n + palatal				
<ny>	<unyen>	/ʌɪn^{y}n̩/	'under'	7
<nj>	<hinja>	/hɛn^{y}ʌ/	'behind'	6 [67]
ng + palatal				
<ngy>	<hingya>	/hɛn^{y}ʌ/	'behind'	2
<ngj>	<ungjen>	/ʌɪn^{y}n̩/	'under'	2
Others				
<gg>	<higga>	/hɛn^{y}ʌ/	'behind'	1
<ngg>	<unggen>	/ʌɪn^{y}n̩/	'under'	1
<nch>	<hincha>	/hɛn^{y}ʌ/	'behind'	1
?	<u?>	/ʌɪn^{y}n̩/	'under'	1

() total number of responses

* responses per type

[67] Three <jn> sequences (<hijnga> 'behind', <ujnen> and <aujnen> 'under') were not included in the count as it was hard to tell whether the <j> was part of the vowel spelling or the nasal spelling.

3. Spelling Task Conclusions

Various strategies were employed by subjects in their effort to invent a spelling for PD. Many appeared to have adopted spelling conventions from English and/or High German. Of interest were those subjects who had included what is normally considered to be two phonemes in one unit. These subjects used two letters to write pre- and postvocalic resonant plus vowel combinations (98% of the time), for diphthongs they used one letter a little over half the time (55%) and two just under half the time (45%), non-medial palatal consonants were often spelled with one letter (59%) and the affricate /ts/ in initial position was very frequently spelled with one letter (92%).

The palatal consonants and the affricate /ts/ are not found in English (the other language of all subjects). Those who unitized these sounds in the segmentation task, commonly used one letter to represent one segment, although some subjects seemed to be using a digraph strategy, that is, they used a combination of letters to represent a single segment. If subjects spelled a subsyllabic unit with one letter, it can be assumed that for those subjects, that particular unit was inseparable. On the other hand, if they used more than one letter such as for the nucleus (diphthongs, Vr, VN, VL), it was not so clear whether subjects were using digraphs or, due to the nature of the task, were more aware of smaller units and thus reanalyzed these units into two segments. Treiman & Zukowski (1988) suggest that spellers associate groups of graphemes with natural groups of phonemes such as onset, nucleus, coda and rime. If subjects use intrasyllabic units in spelling, perhaps the subjects in this task are accustomed to spelling units such as the nucleus with letter groups containing two vowels or vowels plus <r>, <l>, <n>, <m> or <ng>.

C. General Discussion

It was found that most speakers of PD could segment words into phonemes. Even though the segmentation was usually at the phoneme level, there were some notable exceptions. Postvocalic resonants demonstrated more vowel 'stickiness' than prevocalic resonants. More specifically, vowels followed by [r,l,n,m] were not separated but were given as a single unit 46% of the time, whereas prevocalic [r,l,n,m] were only presented as a unit 16% of the time. The long and short outgliding diphthongs (VV, ʌV) showed a strong tendency to be treated as a unit (99%), but the ingliding diphthongs (Vʌ) were separated in 33% of the cases. The tendency of both pre- and postvocalic resonants to stick to the vowel was affected by syllable structure. The further the resonant was embedded in the syllable, the more likely it was to be treated as part of the vowel. In this respect, the second component of the ingliding diphthongs was more like a postvocalic resonant (particularly postvocalic /r/). When followed by two consonants, postvocalic /r/ was 78% V-sticky and Vʌ was 84% cohesive (see Tables 9 and 13).

Some consonant clusters were apt to be more cohesive than others. Resonants, which in traditional analyses of the syllable are thought to form part of the onset or coda, were hardly ever treated as part of onset or coda consonant cluster. Obstruent clusters on the whole were no more cohesive prevocalically than postvocalically. However, they generally demonstrated more cohesiveness than the clusters containing resonants. The greatest amount of cohesiveness in the fricative-stop clusters was attributable to the affricate /ts/, which was treated as a unit both initially and finally (85% and 59%, respectively).

The results of the spelling task support the above results, although subjects tended to use conventional spellings with no one-to-one correspondence between 'sounds' and graphemes. For example, even though /ar/ in the word /darp/ 'village' was unitized 56% of the time, all but one subject spelled this segment as <ar>. In this instance, the spelling task indicates that the subjects are aware, at least, of the r-quality of the vowels and the spelling may be a simple carry over from English (cf. English /tarp/). The only definitive conclusion that can be drawn from the spelling task is that some subjects, in both written and oral tasks, consistently treat certain subsyllabic units, diphthongs, palatal stops and the affricate /ts/ as single units.

D. Conclusion

The results indicate that knowing the alphabetic writing system of a language may facilitate segmentation of the words into phonemes, and that people who have experience in writing with an alphabetic system, in this case English, can transfer that knowledge, to some extent, to a second language for which there is no written form. The fact that segments such as vowel plus resonants, diphthongs and certain consonant clusters showed a tendency to stick together as a unit in a segmentation task, points to the psychological reality of the sub-syllabic units called the nucleus, onset and coda or, perhaps more accurately, a differential bonding relationship between segments that varies as a function of segment-type and context. These results also call for a re-evaluation of the nucleus as a vowel plus resonant, rather than just a single vowel or diphthong. The ambiguity or inconclusiveness of some of the findings of the combined segmentation and spelling tasks, however, partly motivated the deletion recognition tasks that are outlined in the next chapter.

III. DELETION RECOGNITION TASKS

Using novel word games, Trieman (1983) found support for the validity of onset and rime as primary syllable constituents. Although she did not find evidence for subdivision of the rime in her 1983 study, her later investigation of the internal structure of the rime (Trieman, 1984) found that subjects treated final consonant clusters differently, depending on whether the first element of the cluster was an obstruent or a resonant. She noted that obstruents formed a cohesive unit with final consonants and that postvocalic /l/ and /r/ were treated as a unit with the vowel, but that postvocalic nasals could either be linked with the vowel or with the final consonant. In other words, postvocalic obstruents were part of the coda, liquids part of the nucleus and nasals, either the coda or nucleus. Further, Trieman (1985) found that children by the age of 5 could segment words after the first consonant cluster (i.e., at the onset-rime boundary) and suggested that this was due to the fact that children conceptualize initial consonant clusters as a unit.

Dow (1987) used a deletion-by-analogy task to determine whether intermediate units of onset, nucleus and coda were accessible to children and high school students. The task consisted of the presentation of a word-pair to provide the pattern for deletion (e.g., smile-aisle) followed by a stimulus word (e.g., smart) to which the subject was to supply the target word (e.g., art) on analogy with the first pair. Dow noted a developmental trend in deletion abilities. She found that onsets were significantly easier for young children to delete than codas and that high school students could delete onsets and codas equally well.

Other experimenters have used deletion tasks to test segmentation abilities in general but not to specifically test sub-syllabic units. Morais et al. (1979) had illiterates and late readers[68] delete and add one 'sound' to words and nonwords. The late readers performed better on both tasks. Read et al. (1986), in a replication of Morais et al.'s experiment, compared a group of Chinese adults literate in Chinese characters (nonalphabetic group) with a group also literate in Hanyu pinyin (alphabetic group). There was a significant difference between the two groups in their ability to delete initial consonants, with the alphabetic group outperforming the nonalphabetic group in both the word and nonword conditions.

Interestingly, the results of the last two experiments in the real word condition were similar to Dow's two groups for the onset deletion tasks (Dow: children 42%, teenagers 89%; Morais et al.: illiterates 26%, late readers 87%; Read et al.: nonalphabetic 37%, alphabetic: 93%) which suggests that the developmental trend noted in Dow may be a development of metalinguistic awareness of the phonological structure of speech acquired in the process of learning to read an alphabetic system.

In the previous chapter the experimental method employed was extremely time-consuming as well as labour-intensive for both participants and experimenter. Therefore, a different method was sought that would allow for testing a group of people efficiently. Derwing, Dow and Nearey (1987) employed a new experimental technique based on Dow's (1987) 'by-analogy' task. One of their tasks was an onset deletion recognition task in which a group of subjects were trained to delete everything before the vowel sound, then listened to word-pairs and judged whether

[68] "Late readers" are subjects who have learned to read after the age of 15.

the new word-pair was an example of the pattern they had been taught. They found that when presented with word-pairs such as /pleyk/-/eyk/ subjects tended to say that this followed the pattern but pairs such as /pleyk/-/leyk/ did not. That is, resonants (other than glides) in prevocalic position tended to adhere to the consonantal onset rather than to the vowel.

It was felt that this new technique used by Derwing et al. could be employed in a different language, PD, and similar results would obtain. Although Derwing et al.'s subjects were literate English speakers, they used nonsense words as stimuli, to lessen the possible influence of orthographic interference. Therefore, it is expected that the results in the present task will be similar to those found by Derwing et al. To further explore the status of final consonant clusters containing obstruents and resonants in PD, the same technique was also extended to include a coda deletion task.

Due to the cohesiveness of certain vowel plus resonant sequences and some consonant clusters in the segmentation task above (Ch. 2), it was felt that further investigation with emphasis on these particular units was warranted. A second motivation for this study was to find out where natural breaks in PD would occur, e.g., where any onset-nucleus and nucleus-coda boundaries were and what the nature of the nucleus might be. A third motivation was to find out if other factors such as age differences and exposure to the written form of a related dialect might make any differences in the answers given.

This experiment consists of three tasks: Task A, final consonant deletion; Task B, initial consonant deletion; and Task C, coda deletion. Each of the tasks were designed to investigate specific phoneme sequences. Task A involves final stop-fricative and fricative-stop consonant clusters including /ts/, which has traditionally been considered to be a single-segment affricate in German (the

English affricates, /tš/ and /dž/ are also included). Task B looks at these and other fricative stop combinations in initial position. Other initial consonant clusters consisting of obstruent plus resonant (with special emphasis on the palatalized stop phonemes, /k^y and g^y/) are also investigated in Task B. In Task C, postvocalic resonants, short and long diphthongs have been included. Thus, Task B combines elements of both Tasks A and C, but in prevocalic position, whereas Tasks A and C look at specific clusters in postvocalic position.

A. Method

1. Treatment Groups

There were two treatment groups, group 1 and group 2. Treatment group 1 were given Task A followed by Task B. Treatment group 2 were given Task C and then Task B. Tasks A and C were not given to the same subjects as it was found in a pilot study that this combination of two post-vocalic deletion tasks resulted in confusion.

2. Subjects

Sixty-two speakers of PD took part in this study. They were randomly assigned to and tested in groups. There were 13 adults (males=5; females=8) and 17 children (males=7; females=10) assigned to treatment group 1, with 14 adults (males=6; females=9) and 17 children (males=10; females=7) assigned to treatment group 2.

Adults were between the ages of 16 and 65 years. (Included in the group 1 adults were a 16-year-old and a 17-year-old who were in grades 11 and 12 in Swift Current, Saskatchewan.) The children ranged in age from 7 to 15 years and 27 attended the Wymark Elementary School (approximately 20 km south of Swift Current), which teaches grades 1 to 9 only. The other seven children were from four families who attended a home school run by their parents (about 10 km south of Swift Current, also in the Wymark area). The home-school children were between the ages of 8 and 13. The age range for adults and children per task is listed below.

Table 24. Age Range of Adults and Children Per Task.

	Final C deletion (A)	Initial C deletion (B)	Coda deletion (C)
Adults	17-60 (n=13)	16-65 (n=26)[69]	16-65 (n=14)
Children	8-15 (n=17)	7-15 (n=34)	7-14 (n=17)

Subjects were screened for PD competence by the Principal of the Wymark school and by Margaret and Henry Fehr, secretary/treasurers of the Bridgeway Mennonite Church in Swift Current.[70]

3. Procedure

A female native PD speaker (age 50) was trained to read phonetic script. With the experimenter present, she practiced reading the stimuli for each task over the next two days. The stimulus items were recorded on a portable Sony TC K5511 stereo cassette player using a Sony Electret Condenser ECM-200 Microphone. Each pair of stimulus items were repeated once at a rate of approximately one word per second with a break of three seconds between each set.

[69] One subject participated only in the coda deletion task.
[70] These three are all natives to the Swift Current area and regular speakers of PD.

In each task, subjects were first trained to delete initial or final consonants on 10 items. Then they were given 6 practice items for which the answer YES (it fits the pattern) or NO (it does not fit) was supplied and the correct form subsequently given if the answer was NO. At this time, subjects were asked if there were any questions and practice items were repeated if necessary. This was followed by the task proper. In each task, in order to reinforce the nature of the task and to provide a control, the test items were interspersed with 17 reinforcement items which were the same as the training and practice items. (Please refer to Appendix II for a complete list.) Subjects were given a 10-minute break between tasks.

All subjects were tested in groups. The adults were tested in a classroom of the Swift Current Composite High School. The children were tested in the library of the Wymark Elementary School or in the open classroom of the home-school. For each task the subjects listened to the prerecorded training, practice and test items presented aurally on a Sony stereo cassette player.

a) Training

Subjects were told that they were going to learn to recognize words in which the final sound (Task A), the initial sound (Task B) or all the sounds after the vowel (Task C) had been deleted. The subjects were then trained to recognize the deletion for the particular task on 10 items as illustrated in Table 25 below.

Table 25. <u>Sample Deletion Recognition Training Items</u>

Task A: C# deletion recognition	CVCC - CVC	/dωps/ - /dωp/
Task B: #C deletion recognition	CCVC - CVC	/špωk/ - /pωk/
Task C: coda deletion recognition	CVCC - CV	/lɔft/ - /lɔ/

b) Practice Session

Immediately following the training session the subjects were given a practice session consisting of 6 items, 3 correct items and 3 incorrect items to which the correct answer was supplied. For example:

Table 26. <u>Practice Session Format</u>

"/fɛft/ - /fɛ/
/fɛft/ - /fɛ/ NO
(pause)
The correct answer is
/fɛft/ - /fɛf/"

The correct answers were supplied in the practice session in order to reinforce the target pattern as illustrated in Table 27:

Table 27. <u>Sample Deletion Recognition Practice Items</u>

Task A: C# deletion recognition	CVCC	- CVC	/šæps/ - /šæp/
Task B: #C deletion recognition	CCVCC	- CCVC	/frωçt/ - /frωç/
Task C: coda deletion recognition	CVCC	- CV	/prɪps/ - /prɪ/

B. Analysis

The YES-NO answers from each subject along with some personal information about sex, age, schooling, etc., were transferred to optical scoring sheets. An item analysis of the individual items or word-pairs for each task was done on the Michigan Terminal System main-frame computer at the University of Alberta. As part of the item analysis, a "correct" answer for each item was compared with the percentage of YES and NO answers. These results were analyzed by deletion type.

The data were further analyzed using signal detection procedures (McNicol, 1972; Derwing et al., 1987). See Table 28 below for a characterization of the four overt response types.

Table 28. Response Types

Stimulus	*Response* YES	NO
CORRECT	HIT	MISS
INCORRECT	FALSE ALARM	CORRECT REJECTION

The responses to the stimuli were coded as a HIT if a YES answer was supplied to a "nominally correct" stimulus and as a MISS if a NO answer was supplied for a "nominally correct" stimulus. Similarly, a response was coded as a FALSE ALARM (FA) if an "incorrect" stimulus item was given a YES answer and as a CORRECT REJECTION (CR) if an "incorrect" stimulus item was given a NO answer. The data from the FAs and CRs eliminates the possibility that the subject is randomly guessing. Once the data were coded in this fashion, a pattern detectability measure, *d'*, was calculated as a function of HITs, MISSes, FAs and CRs, using the formula in Figure 1.[71]

Figure 10. Calculation of *d'*

$$d' = \log \left(\frac{HIT \times CR}{FA \times MISS}\right) \times .001$$ [72]

The data from each task were divided into deletion types (see Procedure section above for types). In each task, a one sample two-tailed t-test of *d'* against a mean of 0 was conducted per type in order to ascertain if the *d'* for that type reached significant positive values, that is, whether or not the HIT rate was significantly greater than the FALSE ALARM rate. This test was performed to determine the relative separability or cohesiveness of consonant clusters (Tasks A and B), and of prevocalic and postvocalic resonants (Tasks B and C). To test for relative differences in separability and cohesiveness between types, paired-difference t-tests of *d'* were conducted for each task.

A series of three-factor repeated measures ANOVAs was run to determine whether age, sex, or German schooling had any effect on the results.[73] For all tasks, sex was found not to be significant, so no further analysis was done on the basis of sex. A discussion of the effects of age and German schooling will follow in the results section for each task.

[71] This *d'* is based on the logistic measure.
[72] The factor .001 was added to prevent dividing by zero.
[73] The statistics package used was Statview.

C. Task A: Final Consonant Deletion

1. Procedure

Task A consisted of 75 test items presented randomly. A list of training, reinforcement and test items for Task A are given in the appendices.

a) Training

Subjects were told that they were going to learn to recognize words in which the final sound had been deleted. The subjects were trained to delete the final consonant on 10 items ending with a CC cluster, where the final consonant cluster was a stop plus fricative (3 training pairs), a fricative plus stop (5 pairs) or a fricative plus fricative (2 pairs), as illustrated in Table 29 below.

Table 29. Sample Final Consonant Deletion Training Items

CVCC - CVC	/dωps/ - /dωp/
CCVCC - CCVC	/štɪft/ - /štɪf/
CCVVCC - CCVVC	/blʌɪfs/- /blʌɪf/

b) Practice Session

Immediately following the training session the subjects were given a practice session consisting of 6 items, 3 correct items and 3 incorrect items to which the correct answer was supplied. For example:

Table 30. Practice Session Format

"Number 1.
daks - dak
daks - dak YES
(pause)
Number 2.
/fɛft/ - /fɛ/
/fɛft/ - /fɛ/ NO
(pause)
The correct answer is
/fɛft/ - /fɛf/"

The correct answers were supplied in the practice session in order to reinforce the target pattern. The subjects practiced on items that had either a stop plus fricative (3 items) or a fricative plus stop (3 items) final consonant cluster as illustrated in Table 31:

Table 31. Sample Final Consonant Deletion Practice Items

CVCC - CVC	/šæps/ - /šæp/
CCVCC - CCVC	/frωçt/ - /frωç/

c) Test

The 75 test items consisted of the following final consonant clusters (with the number of test items per type given in parentheses): /št/ (10), /st/ (20), /ts/ (22), /tš/ (9), /kš/ (9), /dž/ (5).

There were various types of deletions possible, depending on whether or not the word had 2, 3, or 4 consonants in the final consonant cluster, and whether or not the nucleus consisted of a single vowel or a diphthong.

Table 32. Final Consonant Deletion Test Items

Type	Correct deletions	Incorrect deletions	
VCC	/lωtš/-/lωt/	/lωtš/-/lω/	---
VCCC	/šmεηkš/-/šmεηk/	/šmεηkš/-/šmεη/	/šmεηkš/-/šmε/
VCCCC	/fωηkst/-/fωηks/	/fωηkst/-/fωηk/	/fωηkst/-/fωη/
VVCC	/miʌšt/-/miʌš/	/miʌšt/-/miʌ/	/miʌšt/-/mi/
VVCCC	/haults/-/hault/	/haults/-/haul/	/haults/-/hau/
			/haults/-/ha/

The five presentation types involved are illustrated in Table 32. As in all subsequent deletions tasks, all input strings are real PD words and most output strings are phonotactically possible PD words.[74]

For the test section subjects were told to circle YES on their answer sheets for word-pairs in which the final sound was deleted and NO where the pairs did not match the pattern they had learned in the training and practice sessions.

2. Results and Discussion

In this task subjects were to judge whether the final consonant in a word-pair was deleted or not. (Thus deletion of a single final consonant is defined as the "nominally correct" pattern). If subjects correctly judged that the final consonant in a pair with the form CVCC-CVC was deleted, this was coded as a HIT. A high HIT rate would indicate consonant separability, or a tendency for the cluster to separate and not to be treated as a unit. A FALSE ALARM corresponds to a YES reply for

[74] The only exceptions are output strings ending in lax vowels such as /šmε/.

a pair of the type CVCC–CV. In this case the consonants would have deleted together and a high FALSE ALARM rate would suggest consonant cohesiveness, or a tendency to be treated as a unit.

Note that the FALSE ALARM and HIT rates need not add up to 100% as the rates are based on related but not identical pairs of words. For example, if 19 of the 30 (63%) subjects answer YES to the pair /lωtš/-/lωt/ and 11 (37%) answer NO, then the HIT rate is 63% and the MISS rate is 37%. If on the other hand, 9 subjects (30%) reply YES to the pair /lωtš/-/lω/, and 21 (70%) reply NO, then the FALSE ALARM rate is 30% and the CORRECT REJECTION rate is 70%. In reporting these numbers it is not necessary to indicate both the HIT and MISS rates or both the FALSE ALARM and CORRECT REJECTION rates as the MISS rates are recoverable from the HIT rates and the CORRECT REJECTIONS are recoverable from the FALSE ALARM rates. Therefore, if only the HIT and FALSE ALARM rates are reported these need not add up to 100%, as they are based on different pairs. To use the example, the HIT rate for /lωtš/-/lωt/ was 63% and the FALSE ALARM rate for the related pair /lωtš/-/lω/ was 30%. These do not add up to 100% as they are taken from two different sets of answers.

A measure of detectability of the nominally correct pattern, or the *d'*, has been calculated as a function of the HIT and FALSE ALARM rates (See Figure 10 above). A large *d'* value results from a high HIT rate and a low FALSE ALARM rate. In this case a high HIT rate as well as a low FALSE ALARM rate with a resulting high positive *d'* value means that word-final fricative-stop clusters are separable, that is, they are not treated together as a unit. A low HIT rate and a high FALSE ALARM rate with large negative *d'* values would mean that the final consonants were mutually cohesive or tended to act as a single unit.

For ease of discussion, the final consonant clusters tested in Task A have been divided into two groups, final fricative-stop and final stop-fricative clusters.

a) Final Fricative-Stop Clusters

The final fricative-stop clusters examined in this task are all sibilant fricatives plus the final stop, /t/. The three types, /-št/ (št), /-st/ (st) and /-Rst/ (Rst where R = post-vocalic resonant) are listed in the first column in Table 33 below.

The next two columns contain examples of word-pairs in which a YES answer would result in a HIT or a FALSE ALARM (FA) are listed. A HIT corresponds to a YES reply for the pair /nɷšt/ - /nɷš/ and a FALSE ALARM corresponds to a YES reply for the pair /nɷšt/ - /nɷ/. Columns 4 and 5 contain the number of YES answers, given in percentages, which would constitute HITS and FALSE ALARMS for the three types. (The MISSes and CORRECT REJECTIONs, i.e., the NO answers to /nɷšt/ - /nɷš/ and /nɷšt/ - /nɷ/, are not included in Table 33, as these scores are recoverable from the HIT and FALSE ALARM rates.) The final column contains the mean of the *d'* values for a particular fricative-stop cluster type as well as the results of a two-tailed t–test of *d'* against 0 as a measure of consonant stickiness.

Table 33. Deletion of Final Fricative-Stop Clusters.

TYPE	EXAMPLES		% YES		*d'*
	HITs	FAs	HITs	FAs	Mean
št	nɷšt-nɷš	nɷšt-nɷ	80.83	21.67	4.79***
st	lɔst-lɔs	lɔst-lɔ	80.37	33.33	3.65***
Rst	dɔnst-dɔns	dɔnst-dɔ	80.00	18.70	4.89***

***significant $p<0.001$

From the above table it can be seen that the deletion of a final stop (in this case always /t/) from a word-final fricative-stop cluster has an approximate HIT rate of 80%. If we compare this with the HIT rate of 93% for the reinforcement items, that is, the training and practice items which were interspersed amongst the test items, the HIT rate of 80% for the fricative-stop deletion is relatively low. The FALSE ALARM rate, on the other hand, is relatively high, especially in the case of the alveolar fricative (st). One-third of the time, listeners said YES to word-pairs like /lɔst/–/lɔ/, where the fricative was deleted along with the stop.

In the final column of the above table, it can be seen that *d'* for all three types reaches significant positive values. This means that the HIT rate for all of the final fricative-stop clusters was significantly greater that the FALSE ALARM rate. The values of *d'* in this column would also suggest that there is more of a tendency for st (alveolar fricative plus /t/) to stick together than for št. Final clusters containing a resonant followed by a fricative plus stop (Rst) have the highest *d'* rates (and the lowest FAs). This suggests that Rst clusters are the least likely to be deleted as a unit, that is, they exhibit the least overall consonant cohesiveness, which is the expected result, since three potential segments are involved rather than just two.

To test for any relative difference in consonant stickiness, a paired difference t–test of *d'* was conducted. The results of this t–test are listed in Table 34 below.

Table 34. Statistical Significance (p<) of Relative Differences for Final Fricative-Stop Clusters

	Rst [4.89]	št [4.79]	st [3.65][75]
Rst		ns	0.005
št	ns		0.005
st	0.005	0.005	

[]=*d'* scores
ns= not significant (p>.05)

The results indicate that Rst is significantly different in stickiness from st, but not št, and that st and št are significantly different that each other. This would suggest that a final cluster of the type št is significantly less cohesive than a final cluster of the type st and that the final cluster of the type Rst, while least likely to behave as a cohesive unit, is not significantly less cohesive than št. A relative consonant-stickiness hierarchy could be set up as shown in Figure 11:

Figure 11: Final Fricative-Stop Cohesiveness Scale

relative cohesiveness

——————————————>

Rst, št < st

with Rst and št at the lower end of the cohesiveness scale (less cohesive, more tendency to separate) and st at the higher end of the cohesiveness scale (more tendency to stick together).

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[75] Please note that in this and subsequent tables the upper right triangle (the shaded portion) is identical to the lower left triangle (unshaded). This repetition is for ease of reading only.

b) Final Stop-Fricative Clusters

The final stop-fricative clusters under examination in this task include a variety of voiced and voiceless obstruent combinations. Two of these clusters (/-dž/ and /-tš/)[76] are affricates in English and one (/-ts/) is an affricate in High German.[77] It is a matter of conjecture as to whether, in a phonological description, affricates form a single functional unit or a sequence of two phonemes which function as separate units (Hawkins, 1984; Crystal, 1985). If affricates form a unit functionally, then they should be harder to separate. If they are a sequence of sounds, then they should be more readily separated, and combinations such as /st/ and /ts/ should be treated in a like manner.

The four different CC-types are /-ts/, /-tš/, /-kš/ and /-dž/ (designated in column 1 in Table 35 as <u>ts</u>, <u>tš</u>, <u>kš</u>, <u>dž</u>). The analysis also included one other type of final consonant cluster, viz., a post-vocalic resonant followed by /-ts/ (designated below as <u>Rts</u>).

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[76] Although rare, initial /tš/ and /dž/ are also present in High German in loan words.

[77] The affricate /pf/ is also present in High German and most southern German dialects, but does not occur in PD, which originates from northern German dialects.

Table 35. Deletion of Final Fricative in Stop-Fricative Clusters

TYPE	EXAMPLES		% YES		d'
	HITs	FAs	HITS	FAs	Mean
ts	mɛts-mɛt	mɛts-mɛ	75.83	37.50	2.81***
tš	ditš-dit	ditš-di	61.67	30.00	2.55***
kš	bɷkš-bɷk	bɷkš-bɷ	58.33	25.00	3.10***
dž	žɛrdž-žɛrd	žɛrdž-žɛr	61.67	60.00	0.21
Rts	grɷnts-grɷnt	grɷnts-grɷ	76.67	14.00	4.63***

***significant $p<0.001$

The average HIT rate (approximately 67%) is somewhat lower for final stop-fricative clusters than for the final fricative-stop clusters (80%) discussed in the last section (p. 86). The highest HIT rate with lowest FALSE ALARM rate is for the Rts type. This is reflected in a high positive *d'* value of 4.63 which would suggest that in words containing a post-vocalic resonant plus /ts/, the final stop plus fricative is separable (grɷnts-grɷnt; 77%), and a final resonant + stop + fricative cluster is consequently unlikely to be treated as a unit (grɷnts-grɷ; 14%).

It would appear from Table 35 that final dž is equally likely to be treated as a unit or as separate sounds. Note that the HIT and FALSE ALARM rates are virtually identical (62% and 60%), that the *d'* rate, although still positive, is very low (0.21) and is not significant. This means that the HIT rate is not significatly greater than the FALSE ALARM rate.[78] It is perhaps worth noting this is the only case in the FA set where the output form does not end with a simple vowel.[79]

[78] English spelling, where /dž/ is spelled as <j> and <dge> as in <judge> or <ge> as in <page>, may be influencing subjects judgements.
[79] It could be assumed that the right answer would always end in a vowel so that subjects could develop a task strategy. This, however, does not appear to be the
(continued on next page)

The *d'* rates for the rest of the final stop-fricative types, namely ts, tš and kš are all positive and indicate a significant difference between the HIT and FALSE ALARM rates. This suggests a general tendency for voiceless final obstruent clusters to separate. However, the lower HIT rates of 58% for kš, and of 62% for both tš and dž indicate that subjects were less certain as to the separability of final stop-fricative clusters containing palatal fricatives. Table 36 below containing the results of a paired difference t-test of *d'* for the different stop-fricative types indicates the relative differences of consonant cohesiveness.

Table 36. Statistical Significance (p<) of Relative Differences for Final Fricative in Stop-Fricative Clusters

	[illegible]	[illegible]	ts [2.81]	tš [2.55]	dž [0.21]
Rts			0.01	0.01	0.001
kš	0.01		ns	ns	0.001
ts	0.01	ns		ns	0.01
tš	0.01	ns	ns		0.05
dž	0.001	0.001	0.01	0.05	

[]=*d'* scores
ns= not significant (p>.05)

The results show that dž is significantly more cohesive than all the other final fricative-stop clusters. On a cohesiveness scale, then dž would be at the high end. The results also suggest that as ts, tš and kš are not significantly different from one another, that is, they are about equal in cohesiveness. Therefore, a cohesiveness scale could be constructed as follows.

________(continued)
case. Note that in other instances the presence of an output-final tense vowel (such as in /di/) yields about the same result as an output-final lax vowel (as in /mɛ/ or /bɷ/), cf. note 74.

Figure 12: Final Stop-Fricative Cohesiveness Scale

relative cohesiveness

——————————>

kš, ts, tš < dž

Finally, resonants followed by stops plus fricatives (Rts) are significantly different from the other final fricative-stop clusters not preceded by a resonant. This test for the last type, Rts, is somewhat different from the others in this table. The HIT rate, which is indicative of a "correct" answer to a deletion of a final consonant, is similar to the others in the set. The FALSE ALARM rate, however, is quite different (see p. 85). The deletion pattern of the incorrect deletion type is also different. The others delete the final stop-fricative cluster (CVCC-CV), while Rts deletes the final cluster as well as the preceding resonant (CVRCC-CV). It was decided that the best comparison would be between /-Rts/ from the stop-fricative set and /-Rst/ from the fricative-stop set, as they have identical deletion patterns.

c) Final Clusters Containing Prevocalic Resonants

A comparison was made of the final obstruent clusters of the type RCC (resonant followed by two consonants), namely, Rst and Rts. Their HIT rates, FALSE ALARM rates and *d'* values are repeated below for ease of comparison.

Table 37. Deletion of Final RCC Clusters

TYPE	EXAMPLES		% YES		*d'*
	HITs	FAs	HITS	FAs	Mean
Rst	dɔnst-dɔns	dɔnst-dɔ	80.00	19.00	4.89***
Rts	grɷnts-grɷnt	grɷnts-grɷ	76.67	14.00	4.63***

***significant $p<0.001$

Notice that the HIT and FALSE ALARM rate for both Rst and Rts are similar and the *d'* rate values are virtually identical. Both of their *d'*s reach significant positive values. A paired difference t-test of *d'* for Rts and Rst shows that the final stop-fricative of Rts is not significantly more cohesive than the final fricative-stop of Rst. This means that consonant clusters containing a voiceless sibilant fricative and an alveolar stop, when preceded by a resonant, are separable and are not likely to be treated as a unit and that the order of fricative and stop is not significant.

A comparison was made of final voiceless-sibilant-fricative-plus-stop clusters preceded by a single vowel or a resonant (Vst or Rst), and of final stop-plus-voiceless-sibilant-fricative clusters preceded by a single vowel or a resonant consonant (Vts or Rts) to see if the presence or absence of a resonant consonant in the final cluster affects the cohesiveness of the final obstruent cluster.

Table 38. Deletion of Final (R)CC Clusters

TYPE of final CC		EXAMPLES		% YES		*d'*
		HITs	FAs	HITS	FAs	Mean
st	Vst	lɔst-lɔs	lɔst-lɔ	79.33	19.33	4.69***
	Rst	dɔnst-dɔns	dɔnst-dɔn	83.33	27.33	4.89***
ts	Vts	mɛts-mɛt	mɛts-mɛ	67.33	23.33	3.26***
	Rts	grɷnts-grɷnt	grɷnts-grɷn	73.33	52.67	2.35***

***significant $p<0.001$

Table 38 shows that the clusters preceded by resonant consonants (Rst and Rts) have higher FALSE ALARM rates than those preceded by a vowel (Vst and Vts). It seems, then, that the preceding resonant affects the cohesiveness of the following obstruent cluster.

The HIT rates and *d'* rates for final st are generally higher than for final ts clusters. This indicates that final ts is more likely to be treated as a unit than st, regardless of whether they are preceded by a single vowel or a vowel plus resonant consonant. Therefore, the order of obstruents in the final cluster itself affects subjects' deletion recognition choices. But the lower HIT rate for Vts and the much higher FALSE ALARM rate for Rts suggests that speakers have more difficulty deciding whether to treat ts as a unit or not.

The results of a paired-difference t-test are given in Table 39 below.

Table 39. Statistical Significance (p<) of Relative Differences of Final (R)CC Clusters

	Rst[5.89]	Vst[4.69]	Vts[3.26]	Rts[2.35]
Rst		ns	0.01	0.001
Vst	ns		0.05	0.001
Vts	0.01	0.05		ns
Rts	0.001	0.001	ns	

[]=*d'* scores
ns= not significant (p>.05)

Note that there is no signficant difference between final Vst and Rst, nor between final Vts and Rts. There is, however, a signficant difference between V/Rst and V/Rts. Therefore, the order of obstruents in the final consonant cluster itself significantly affects the choices subjects make. Whether or not the final obstruent cluster is preceded by a resonant consonant or vowel may also affect subjects' choices, but this effect is not significant.

d) Comparison of All Final Clusters not Preceded by a Resonant

Using a paired difference t-test of *d'*, a comparison was made of all the final fricative-stop and stop-fricative clusters not preceded by a resonant consonant. The results of this test can be seen in Table 40 below.

Table 40. Statistical Significance (p<) of Relative Differences for Final Obstruent Clusters

	št [4.79]	st [3.65]	kš [3.10]	ts [2.81]	tš [2.55]	[illegible]
št		0.005	0.005	0.001	0.005	[illegible]
st	0.005		ns	0.05	ns	[illegible]
kš	0.005	ns		ns	ns	[illegible]
ts	0.001	0.05	ns		ns	[illegible]
tš	0.005	ns	ns	ns		[illegible]
dž	0.001	0.001	0.001	0.01	0.05	

[]=*d'* scores
ns= not significant (p>.05)

In Table 40 above it can be seen that <u>št</u> is significantly different from all others. If the HIT and FALSE ALARM rates for <u>št</u> are compared with those of the other final obstruent clusters (see Tables 33 and 35 on pp. 85 and 89), it can be seen that <u>št</u> has the highest HIT rate and the lowest FALSE ALARM rate as well as the highest mean *d'* value. These facts, coupled with the results of the paired difference t-test would suggest that <u>št</u> is significantly less cohesive than <u>st</u>, <u>ts</u>, <u>tš</u>, <u>kš</u> and <u>dž</u>.

The only voiced word-final obstruent cluster, <u>dž</u>, is also significantly different from the voiceless clusters. Again, a comparison of the HIT and FALSE ALARM rates of <u>dž</u> and the other obstruent clusters (see Tables 33 and 35 on pp. 85 and 89) reveals that <u>dž</u> has the second lowest HIT rate (only <u>kš</u> is lower), the highest FALSE ALARM rate, and the lowest mean *d'* value. These facts in conjunction with the paired difference t-test results indicate that dž is more cohesive than the other final obstruent clusters.

A cohesiveness scale could be built with št at the low end of the scale (least cohesive) and dž at the high end of the scale (most cohesive). The other clusters, st, ts, tš and kš, are in the middle and, as there are generally no significant differences among these pairs, it can be concluded that they are about equal in stickiness. They are separated by commas in Figure 13 below to indicate that they do not significantly differ in relative cohesiveness.

Figure 13: Final Obstruent Cluster Cohesiveness Scale

relative C-cohesiveness

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št < st, ts, tš, kš < dž

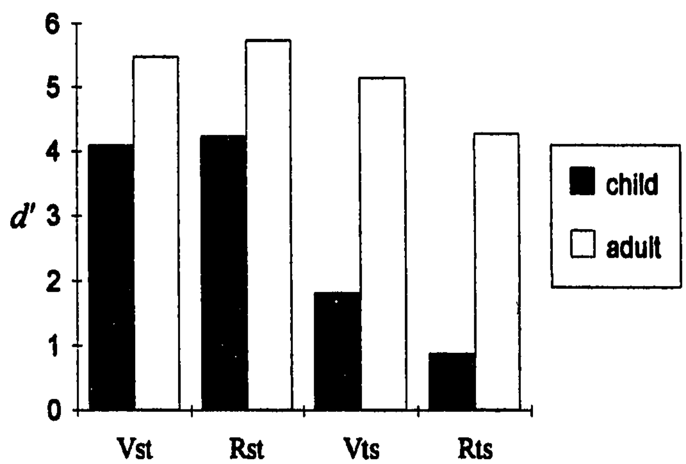
To reiterate, št is less cohesive and, therefore, less likely to delete as a unit than any of the other final obstruent clusters. The voiced cluster, dž, is more cohesive and the likelihood of its being treated as a unit is greater than the other word-final obstruent clusters. The other four (ts, tš, kš, st) will sometimes be treated as a unit, especially tš and kš which have quite low HIT rates and fairly high FALSE ALARM rates. One of the so-called affricates, dž, acts more like a unit than the rest. Note that ts and tš, affricates, and st, a non-affricate, are about equally likely to be treated, word-finally, as units in this language.

e) **Subject Differences**

Two-factor[80] repeated measures ANOVAs were run pooled over the eight types of final consonant clusters with 2 levels of age (adults vs children) and with 2 levels of German schooling (no school vs some school). It was found that age was significant at the .05 level, but there were no age-task nor German schooling-task interactions. See Figures 14 and 15 below for a summary of means.

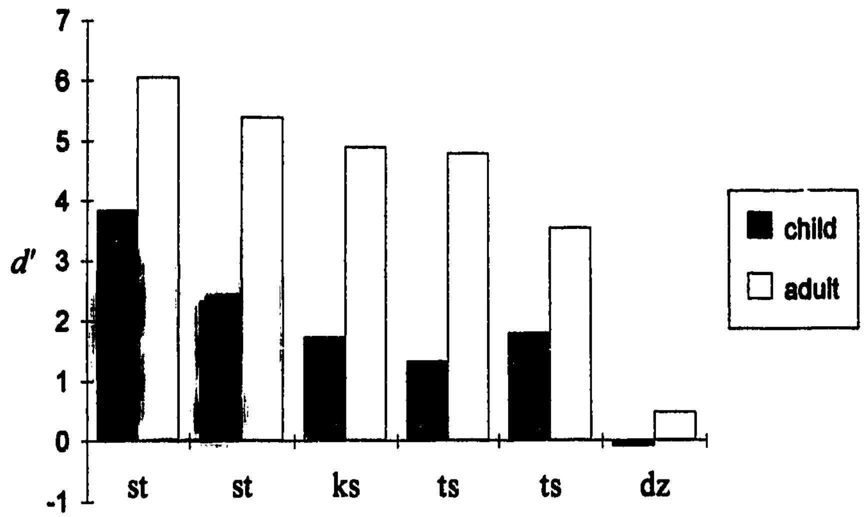
(1) **Effects of Age**

Figure 14: Final (R)CC Clusters. Type by Age



[80] Because of lack of numbers in some of the cells, a complete three factor ANOVA was not possible.

Figure 15: Final Obstruent Clusters. Type by Age



For all types of final clusters, adults had higher *d'* values than children. A high *d'* value is indicative of a high HIT rate and a low FALSE ALARM rate, which means that the final cluster is separable. Thus, it seems that final consonant clusters are less likely to be treated as a unit by adults than by children. The differences between adults and children indicates a developmental trend with increasing ability to separate clusters either with age or with language use. It might also indicate differences in attention levels or in test-taking abilities between children and adults.

D. Task B: Initial Consonant Deletion

Task B consisted of 73 randomly presented test items. See the appendices for a complete list of the training, practice and test word-pairs for Task B.

1. Procedure

a) Training

Subjects were told at the beginning of this task that they would be taught to recognize the deletion of one sound at the beginning of a word. Subjects were trained to delete the initial consonant on words with one of the canonical shapes illustrated in Table 41.

Table 41. Sample Initial Consonant Deletion Training Items

CVC -	VC	/tit/ - /it/
CCVC -	CVC	/špωk/ - /pωk/
CCCVC -	CCVC	/šplet/ - /plet/

The single initial consonants on the training items were either a stop (1 item) or a fricative (2). Where there were two initial consonants, the consonant cluster consisted of either a stop plus fricative (3) or a fricative plus stop (3). There was also one training item with three initial consonants, which were initial stop followed by fricative plus resonant.

b) Practice Session

There were 6 practice items, 3 correct and 3 incorrect. Answers were supplied and for the incorrect items the correct answer was also modelled as in Task A (Figure10, p. 80). The initial consonant clusters of the practice items were fricative-fricative (1), stop-fricative (2), fricative-stop (2) and fricative-stop-resonant (1) consonant clusters.

c) Test

The test items consisted of the following initial consonants or consonant clusters: 12 initial obstruents followed by a resonant (OR); 32 initial palatalized stops /k^y,g^y/ (C^y), 24 of which were followed by a resonant (C^yR); 15 initial fricatives followed by a stop (FS) and optional resonant (FSR); 14 initial stop-fricative clusters (SF). The following are examples of the different correct and incorrect deletion types used in this task:

Table 42. <u>Initial Consonant Deletion Test Items</u>

Type	Correct Deletions	Incorrect Deletions	
ORV	/šmɔk/-/mɔk/	/šmɔk/-/ɔk/	
C^yV	/g^yɛn/-/ɛn/	/g^yɛn/-/yɛn/	
C^yRV	/k^yriz/-/riz/	/k^yriz/-/yriz/	/k^yriz/-/iz/
FSV	/štæp/-/tæp/	/štæp/-/æp/	
FSRV	/štrol/-/trol/	/štrol/-/rol/	/štrol/-/ol/
SFV	/tsap/-/sap/	/tsap/-/ap/	

Subjects in this task were told to circle YES to word-pairs where the initial sound was deleted and NO to word-pairs that did not match the pattern learned in the training and practice sessions.

2. Results and Discussion

In this task the target or "nominally correct" manipulation is to delete the first consonant. If the subject correctly detects that a word-pair exhibits this type of deletion (CCVC-CVC) and chooses YES as an answer, then this is a HIT from the point of view of classical detection theory. A FALSE ALARM occurs when more than one consonant is deleted in word-initial position (CCVC-VC) and the subject responds YES. Whereas a high HIT rate would indicate a tendency for the consonants to separate and not to be treated as a unit, a high FALSE ALARM rate would suggest consonant cohesiveness or a tendency on the part of subjects to unitize the consonant cluster.

The measure of detectability of the nominally correct pattern, *d'*, was calculated in the same manner as in Task A. High positive values for *d'* along with high HIT rates and low FALSE ALARM rates would indicate consonant separability for word-initial consonant clusters. Conversely, low or negative values for *d'* accompanied by a low HIT rate and a high FALSE ALARM rate would imply the cohesiveness of initial consonant clusters.

The results and discussion of the initial consonant clusters will be conducted in three sections: first, the initial non-palatal obstruent clusters will be dealt with; then, the palatal stops; and finally, initial consonant clusters containing prevocalic resonants. The discussion of the initial non-palatal obstruent clusters will be further divided into fricative-stop and stop-fricative clusters.

a) Initial Non-Palatal Obstruent Clusters

(1) Initial Fricative-Stop Consonant Clusters

The first group of initial consonant clusters to be discussed are those in which the initial consonant is a fricative followed by a stop consonant. The only clusters of this type which were tested were voiceless sibilant fricatives plus voiceless alveolar stops.[81] In Table 43 below note that a HIT constitutes a YES to pairs like /stuʌ/ - /tuʌ/, where only the initial consonant is deleted. On the other hand, a YES answer to the pair /stuʌ/ - /uʌ/, where the first two consonants or entire initial cluster is deleted, is scored as a FALSE ALARM.

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[81] Indeed, /st/ and /št/ are the only initial fricative-stop clusters allowed in PD.

Table 43. Deletion-Recognition of Initial Fricative-Stop Clusters

TYPE	EXAMPLES		Percent YES		*d'*
	HITs	FAs	HITs	FAs	mean
st	stuʌ-tuʌ	stuʌ-uʌ	76.67	31.67	3.48**
št	štæp-tæp	štæp-æp	70.83	40.00	2.39**

** significant $p < 0.005$

Initial /st-/ (st) has a higher HIT rate and a lower FALSE ALARM rate than initial /št-/ (št); thus subjects tended to treat št as a unit more often than they did st. The *d'* rate for st, is higher than št, but in both cases the *d'* reaches significant positive values, which means that the HIT rate for both is significantly greater than the FALSE ALARM rate. Therefore, both the initial fricative-stop clusters are not generally treated as single units.

(2) Initial Stop-Fricative Consonant Clusters

The initial stop-fricative clusters tested were /ts-/ (ts), /tš-/ (tš) and /dž-/ (dž).[82] In Table 44 below it can be seen that the HIT rates for stop-fricative consonant clusters are lower than the fricative-stop clusters discussed above. The HIT rate for ts (66%) is much higher than for the other two (tš, 49%; dž, 45%). All of the FA rates are very high. The FAs for the clusters containing palatal fricatives are higher than their HIT rates.

[82] Although /kš-/ occurs word-finally, it does not occur word-initially in PD; therefore, only three stop-fricatives were tested.

Table 44. Deletion of Initial Stop-Fricative Clusters

TYPE	EXAMPLES		Percent YES		d'
	HITs	FAs	HITS	FAs	
ts	tsap-sap	tsap-ap	66.11	59.44	1.15*
tš	tšɔːt-šɔrt	tšɔrt-ɔrt	49.17	60.00	-0.79
dž	džak-žak	džak-ak	45.00	80.00	-2.69***

*** significant $p < 0.001$;
* significant $p < 0.05$

Subjects in general are unsure as to whether ts is a single unit or not. It seems that they like the deletion of the first consonant or both consonants equally well for initial ts (however, the difference between the HITs and FAs is still significant). For initial tš and dž, they generally prefer the deletion of the whole cluster to the deletion of the initial consonant.

The *d'* values only reach significant positive values for ts. This means that the HIT rate for initial ts is significantly greater than the FALSE ALARM rate. The *d'* rate for dž was negative and significant which means that the FA rate was significantly higher than the HIT rate. Subjects clearly preferred to treat dž as a single unit. Interestingly, dž behaves somewhat differently from tš which indicates that subjects are not merely responding on the basis of English. The results suggest that all of these initial stop-fricative clusters are, to a certain extent, treated as a unit. However, the initial clusters tš and dž appear to be more cohesive than initial ts.

A paired difference t-test was conducted to reveal the relative difference in consonant cohesiveness among all of the initial non-palatal obstruent clusters. The results of this t-test can be seen in Table 45.

št	0.05		ns	0.001	0.001
ts	0.01	ns		0.005	0.001
tš	0.001	0.001	0.005		0.05
dž	0.001	0.001	0.001	0.05	

[]=*d'* scores
ns= not significant ($p > .05$)

The results indicated in the above table suggest that št is significantly less cohesive than all of the other initial obstruent clusters except ts. The table also shows that dž and tš are significantly more cohesive than all the rest. The other significant difference is between ts and st with initial ts significantly more cohesive than st.

A cohesiveness scale for word initial non-palatal obstruent clusters (see Figure 16 below) is based on the results shown in Tables 43 and 44 with št lowest on the cohesiveness scale (most likely to be separated) and dž highest or most cohesive.

Figure 16: Initial Non-Palatal Obstruent Cluster-Cohesiveness Scale

relative C-cohesiveness

——————————————————>

st < št, ts < tš < dž

This scale is strikingly similar to the scale for final obstruent clusters (see p. 95). The order of clusters is similar, with dž at the high end of the cohesiveness scale. However here it was possible to differentiate among more of the initial non-palatal clusters (Task B) than the final ones (in Task A), as the affricate t̠š can be seen to behave more as a unit in initial position than in final position. This is consistent with the result of the segmentation task (Chapter 2)[83].

b) Initial Palatal Consonants

The initial palatal consonants present a different problem from the initial clusters we have been discussing. It is not clear whether the palatal stops in PD are actually the palatal stops, [c, ɟ] (Wiebe, 1983); palatalized stops in the velar region, [k^y, g^y]; or, if they are consonant clusters consisting of a stop plus a palatal glide [ky, gy]. For purposes of discussion, the symbols [k^y, g^y], have been arbitrarily chosen with no a priori assumption as to the nature of these segments except that they have both been (tentatively) analyzed as single segments (see Chapter 2). If subjects treat these as a unit, that is, tend not to separate them, then it could be concluded they are palatal stops ([c] and [ɟ]) or even palatalized stops ([k^y] and [g^y]), with the palatal off-glide as an inseparable, integral component. If subjects tend to separate the stop from the following glide in word initial position, then the assumption could be that these are either consonant clusters ([ky] and [gy]) or palatalized stops ([k^y] and [g^y]) where the palatal feature carries more weight than the stop feature. (This argument is based on the fact that when the stop is optionally deleted, the palatal feature can remain, e.g. g^yrʌIn-yrʌIn.[84])

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[83] See p. 122 for a proposed explanation.
[84] Historically, reanalysis or mishearing of these palatal(ized) stops may have occurred, as either form, with or without the stop, is heard in present-day PD (e.g. /g^yrʌIn/ and /yrʌIn/ both mean 'green').

In Table 46 below are listed the results of the initial consonant deletion-recognition experiment for the palatalized stops. For purposes of analysis, the pattern of deletion of the entire initial stop consonant plus palatal component was designated as nominally correct.[85] Note that nothing critical hinges on this decision, however, as the opposite decision (i.e., to treat [k^y] and [g^y] as clusters) would simply have reversed the pattern of HIT versus FA responses. Thus, whenever a subject answered YES to a deletion of the type C^yVC-VC, as in /k^yam/-/am/, then this was scored as a HIT. If the subject answered YES to a deletion of the type C^yVC-yVC, as in /k^yam/-/yam/, then this was scored as a FALSE ALARM. Initial palatal stops which immediately preceded the vowel (C^yV) were analyzed separately from initial palatal stops which were followed by a non-palatal prevocalic resonant, (C^yRV) to see if the addition of the prevocalic glides made any difference in the deletion-recognition scores. The results of this analysis are show in Table 46.

Table 46. <u>Deletion of Initial Palatal(ized) Stops</u>

TYPE	EXAMPLES		Percent YES		*d'*
	HITs	FAs	HITS	FAs	
k^y	k^yam-am	k^yam-yam	77.22	66.94	1.42**
g^y	g^yɛn-ɛn	g^yɛn-yɛn	72.22	62.78	0.94(*)
k^yR	k^ynip-nip	k^ynip-ynip	78.33	65.00	1.74***
g^yR	g^ylad-lad	g^ylad-ylad	74.17	63.33	1.24*

*** significant p<0.001
** significant p<0.005
* significant p<0.01
(*) significant p<0.05

[85] This decision was predicated on the treatment of these segments in Wiebe (1983).

It can be seen in the table above that the pattern of HITs and FALSE ALARMs for both /k^y/ and /g^y/ are very similar to the pattern for /k^yR/ and /g^yR/. The HIT and FALSE ALARM rates for the voiced and voiceless consonants (clusters) differ slightly, with the voiced consonants (clusters) having consistently lower rates. A paired difference t-test of *d'* for the different voicing classes of initial palatal stops yielded no significant differences. That is, voiceless, /k^y(R)/, and voiced, /g^y(R)/, palatal stops in word-initial position are about equal in cohesiveness.

If the two types are collapsed, then the average HIT rate for k^y(R) is 78% and for g^y(R) 73%. The FALSE ALARM rates are 67% and 63% respectively. These very high FALSE ALARM rates suggest that subjects are comfortable with either the deletion of the stop plus palatal component, or just the stop.

In the the final column of the above table it can be seen that the mean *d'* values are also very similar. In all cases the *d'* reaches significant positive values, which means that the HIT rates are significantly greater than the FALSE ALARM rate. This is indicative of a preference for a deletion of the entire stop, rather than a deletion which leaves the palatal glide intact, i.e., C^y(R)VC-(R)VC is preferred over C^y(R)VC-y(R)VC.

It would seem, then, that palatal stops in initial position are sometimes treated as a unit and sometimes as separable, and that a following prevocalic resonant (R) does not make a difference in the cohesiveness or separability of C^y in initial position. The 65% acceptability of deletions of the type C^y(R)VC-y(R)VC, however, argues against the treatment of [k^y] and [g^y] as the single phonemes /c/ and /ɟ/ respectively. However, subjects chose the deletion of the stop plus palatal component for stimuli like C^y(R)VC-VC 75% of the time, suggesting that these are palatalized stops from which the stop component can sometimes be separated out and sometimes not. Perhaps we are dealing with subject-group differences here. That is, initial palatal stops are /C^y/ for some groups and /Cy/ for others. However, the two-factor repeated measures ANOVA revealed no significant subject differences (see p. 109). Thus, it would seem that further testing is necessary to arrive at a definitive answer.

c) Initial Consonant Clusters Containing Prevocalic Resonants

In this experiment, some word-pairs of the form CCRVC-VC and C^yRVC-VC also contained the deletion of everything up to the vowel to ascertain whether, in fact, initial consonant clusters of the type CCR- or C^yR- would be unitized or treated as inseparable units by speakers of PD. A comparison of these "incorrect" deletions was made with those that had the "nominally correct" deletion pattern. In Table 47 below are listed the different types examined. The symbol **C^yR** represents initial [k^y] or [g^y] plus non-palatal prevocalic resonant; **CRV** is an obstruent followed by a non-palatal prevocalic resonant. Both **štR1** and **štR2** have been included as they have slightly different deletion patterns.

Table 47. Deletion of Initial Consonant Clusters with Prevocalic Resonants

TYPE	EXAMPLES		Percent YES		*d'*
	HITs	FAs	HITS	FAs	
C^yR	k^ynip-nip	k^ynip-ip	76.25	30.42	3.08***
štR1	štrɔl-trɔl	štrɔl-ɔl	71.11	30.00	2.93***
štR2	štrɔl-trɔl	štrɔl-rɔl	71.11	41.11	2.60***
CRV	prɔš-rɔš	prɔš-ɔš	76.67	31.11	3.37***

*** significant $p < 0.001$

The HIT rate is approximately 74% for initial consonant clusters containing prevocalic resonants, which suggests that subjects preferred the deletion of the initial consonant over the other deletions. The FALSE ALARM rate for all types is 33%, an indication that initial consonant clusters containing resonants sometimes operate as a unit. All *d'* values were significant which means that the HIT rates for **CRV**, **CVR** and **štR1** and **štR2** are significantly higher than the FALSE ALARM rates. A pairwise t-test of these initial consonant clusters revealed no significant differences, so initial consonant clusters containing prevocalic resonants are approximately equal in cohesiveness. **ŠtR2** is of interest as it seems subjects preferred the deletion of two initial consonants (41% FA rate) over the deletion of all three (30% FA rate) suggesting that /št-/ forms a unit and that the resonant can be separated from this cluster. Generally, separation of the initial consonant(s) from the prevocalic resonant is the preferred response and suggests that prevocalic resonants are not treated as a unit with initial consonant clusters for most PD speakers.

Finally, a comparison can be made of prevocalic and postvocalic consonant clusters containing resonants as shown in Table 48 below.[86]

[86] Compare p. 89 where the issue of the presence versus absence of an output final consonant is discussed.

Table 48. Deletion of Initial and Final Consonant Clusters Containing Resonants

TYPE	EXAMPLES		Percent YES		*d'*
	HITs	FAs	HITS	FAs	
#CCR	štrɔl-trɔl	štrɔl-ɔl	74.67	30.51	3.13***
RCC#	dɔnst-dɔns	dɔnst-dɔ	78.34	16.35	4.75***

*** significant $p < 0.001$

If we compare the results shown in the table above, we can see that the HITs are similar but the FAs for the initial clusters are higher than those for the final clusters. This could be due to the fact that a postvocalic resonant tends to be more vowel-sticky (to form a more cohesive unit with the vowel) than prevocalic resonants, or that prevocalic CCR is more cohesive than RCC.[87] The former supposition is supported by Derwing et al. (1987), who also found increased post-vocalic V-stickiness for English.

d) Subject differences

Two-factor repeated measures ANOVAs were run on the 10 types of initial consonant clusters with 2 levels of age and 2 levels of German schooling. No significant differences were found for age or German schooling. There was also no age-task or German schooling-task interaction for initial consonants. It can be concluded, then, that these kinds of individual differences have no effect on the results.

[87] See also note 73 on output vowels.

E. Task C: Coda Deletion

Task A, Final C deletion, could not adequately test the nature of postvocalic resonants or diphthongs. Thus a test was devised in which subjects were trained to recognize the deletion of all consonants in final position after the vowel, i.e., deletion of the coda. If subjects correctly judged word-pairs such as CVRC-CV, CV^C-CV^, CVVC-CVV and CVVRC-CVV to be representative of the deletion type on which they were trained (i.e., answered YES), then this was recorded as a HIT. Whenever subjects judged word-pairs like CVRC-CVR, CV^C-CV, CVVC-CV, CVVRC-CV and CVVRC-CVVR as correctly representing the target deletion (i.e., answered YES), then this was recorded as a FALSE ALARM.[88]

Task C consisted of 10 training, 6 practice and 77 randomly presented test items interspersed with 17 reinforcement items. The appendices contain a complete list of the word-pairs used in this task.

1. Procedure

a) Training

Subjects were trained to delete everything after the vowel on words where the final consonant cluster was a stop-fricative (3 items), a fricative-stop (5) or a fricative-fricative (2) cluster, as illustrated in Table 49:

[88] One nine-year-old female subject answered YES to everything in Task C, so her answers were removed from the pool of data.

Table 49. Sample Coda Deletion Training Items

CVCC - CV	/dɷps/ - /dɷ/
CCVCC - CCV	/blɪfs/ - /blɪ/

b) Practice Session

Following the training session, the subjects were given 6 practice items in which the final consonant cluster was either a stop plus fricative (3) or a fricative plus stop (3). As in Tasks A and B, 3 of the practice items were correct and 3 were incorrect. Answers were provided for all practice items and correct answers were again modelled for incorrect items.

c) Test

Task C consisted of 5 groups of stimuli which were of the following types: 14 VVC (VV=long diphthongs); 16 VʌC (Vʌ=ingliding diphthongs); 17 VrC (r=/r/); 17 VNC (N=nasal); 12 VLC (L=liquid[89]).

Table 50 provides examples of the types of deletions that were presented to the subjects for judgements.

[89] The liquids in PD are /l/ and /lʸ/.

Table 50. Sample Coda Deletion Test Items

Type	Correct		Incorrect Deletions	
CVVC	/daut/-/dau/		/daut/-/da/	
CV^C	/vuʌt/-/vuʌ/		/vuʌt/-/vu/	
CVrC	/dɛrc/-/dɛ/	/dɛrc/-/de/	/dɛrc/-/dɛr/	
CVLC	/bɔlš/-/bɔ/		/bɔlš/-/bɔl/	
CVNC	/zɛnz/-/zɛ/		/zɛnz/-/zɛn/	
CVVNC	/gaunz/-/gau/		/gaunz/-/ga/	/gaunz/-/gaun/
CVVLC	/mail^{y}k^{y}/-/mai/		/mail^{y}k^{y}/-/ma/	/mail^{y}k^{y}/-/mail^{y}/

Subjects were told that for this task they should answer YES for pairs where everything was deleted after the vowel in the second word of the pair and NO for any other type of deletion.

F. Results and Discussion

The following discussion has been divided into two parts: first, the deletion of final consonant clusters containing postvocalic resonants;[90] second, the deletion of final consonant clusters in words containing diphthongs.[91]

[90] The postvocalic resonants in question are /r/, /l/, /m/, /n/ and /ŋ/
[91] The diphthongs tested are the long diphthongs, /au/ and /ai/, and the ingliding diphthongs, /Vʌ/. Short outgliding diphthongs, /ʌV/, were not tested, as the phonotactics of the language does not allow final /ʌ/ when not preceded by a vowel, that is, Cʌ# is not allowed, but Vʌ# is acceptable. Compare the case of lax vowels: though strings like /dɛ/ and /bɪ/ do not naturally occur in PD, subjects did not object to them; cf. footnote 79.

1. Coda Deletion in Words Containing Postvocalic Resonants

In this type of deletion-recognition, where a HIT means that the postvocalic resonant was deleted along with the following consonants, a high HIT rate would represent a tendency for consonant-stickiness of the resonant, (resonant is C-sticky or part of the coda) and a low HIT rate would represent a tendency for vowel-stickiness of the resonant (resonant is V-sticky or part of the nucleus). On the other hand, a high FALSE ALARM rate in word-pairs where the postvocalic resonant is not deleted would represent a tendency for the resonant to stick to the vowel (V-sticky) and a low FALSE ALARM rate, a tendency for the resonant to stick to the following consonant (C-sticky). Thus, a high HIT rate and a low FALSE ALARM rate along with a high positive *d'* would mean that postvocalic resonants were C-sticky, but a low HIT and high FALSE ALARM rate with a low or minus *d'* would mean that postvocalic resonants were V-sticky.

In the first column of the Table 51 (p. 114) are listed the three types of final consonant clusters under examination in this task, those containing postvocalic /l/ (VLC), /n, m, ŋ/ (VNC) and /r/ (VrC). In the coda deletion task, the target deletion is defined as "everything after the vowel". The vowel before /r/, however, is a neutralized vowel (Wiebe, 1983), so that the quality of the vowel may be intermediate between a lax and a tense vowels. Deletions of -rC resulting in both tense ($\bar{V}$) and lax ($\breve{V}$) vowels were included in the stimulus set, in order to ascertain if either were unduly influencing subjects' judgements. For example, in the stimulus set for words with postvocalic /r/, e.g., /vɪrp/, were included pairs like /vɪrp/-/vɪ/, where the resulting vowel was lax, as well as pairs like /vɪrp/ - /vi/, where the resulting vowel was tense.

Table 51. Coda Deletion of Final Consonant Clusters with Postvocalic Resonants

TYPE	EXAMPLES		Percent YES		*d'*
	HITs	FAs	HITS	FAs	mean
VLC	bɔlš-bɔ	bɔlš-bɔl	75.83	35.83	3.13***
VNC	zɛnz-zɛ	zɛnz-zɛn	73.75	35.42	3.15***
V̆rC	dɛrc-dɛ	dɛrc-dɛr	64.44	36.11	2.16*
V̄rC	dɛrc-de	dɛrc-dɛr	44.00	36.11	0.88

*** significant $p < 0.001$
* significant $p < 0.01$

In Table 51 above it can be seen that the FALSE ALARM rate for postvocalic resonant clusters is fairly consistent (around 36%). This would indicate that there is some tendency for subjects to include following resonants with vowels. However, the HIT rates do not indicate the same consistency, as there appears to be a clear hierarchy of HIT rates. Postvocalic liquids and nasals have a HIT rate around 75% and, thus, could be considered to be less vowel-sticky than postvocalic /r/s, which have much lower HIT rates of 44-64%.

For coda deletion of clusters containing postvocalic /r/, if the resulting vowel is lax, the HIT rate is much higher (64%) than when the resulting vowel is tense (44%). The difference in the HIT rates of lax and tense vowels resulting from the deletion of codas containing /r/ could be due to the fact that subjects feel a deletion that results in a tense vowel is an incorrect deletion because the vowel has changed from lax to tense. Of course, a change in a neutral vowel to a tense (VrC-V̄) or a lax (VrC-V̆) vowel could cause lower HIT rates in general for these pairs. Whatever the reasons, the HIT rates for both V̆rC and V̄rC are lower than those of VLC and VNC.

From Table 51 above, it can also be seen that the mean *d'* rates for postvocalic liquids and nasals are higher than for postvocalic /r/. A paired difference t-test revealed no significant difference between VLC, VNC, V̆rC. Thus, the V-stickiness properties of the three different postvocalic resonants were approximately equal. On the other hand, V̄rC may be marginally different from the other three as shown in Table 52 below.

Table 52. <u>Statistical Significance (p<) of Relative Differences for Final Consonant Clusters with Postvocalic Resonants</u>

	VNC[3.15]	VLC[3.13]	V̆rC[2.16]	V̄rC[0.[illegible]]
VNC				
VLC	ns			
V̆rC	ns	ns		
V̄rC	0.05	0.05	0.05	

[] = *d'* scores
ns = not significant (p>.05)

2. Coda Deletion in Words Containing Diphthongs

Monosyllabic words with putative complex nuclei were also examined in this task. Two types of diphthongs followed by an obstruent (long, VVC, vs. short ingliding, VʌC) are compared. The comparison also included long diphthongs followed by a consonant cluster containing a postvocalic resonant.

For the purposes of analysis, diphthongs were considered to be a sequence of two vowels rather than a vowel plus a glide, in order to underline the similarity of the two types of diphthongs under examination. For diphthongs the nominally correct deletion pattern was thus to delete everything after the second vowel and before any postvocalic resonant. This was done in order to parallel the nominally correct deletion of the codas containing postvocalic resonants above. Here the hypothesis is slightly different as we are not considering whether subjects preferred the inclusion of liquids, nasals, or /r/ in the nucleus (V-sticky) or in the coda (C-sticky), but rather whether the second element of the diphthong forms part of a cohesive unit and whether the following consonant affects this cohesiveness.

In Table 53 below the four types plus examples of word-pairs for deletion recognition are given in columns 1 to 3.

Table 53. Coda Deletion of Monosyllabic Words with Complex Nuclei

TYPE	EXAMPLES		Percent YES		*d'*
	HITs	FAs	HITs	FAs	mean
VVLC	bault-bau	bault-ba	58.83	75.83	-2.31**
VVNC	gaunz-gau	gaunz-ga	73.33	60.00	0.92
V^C	piʌt-piʌ	piʌt-pi	52.92	59.17	-0.42
VVC	daut-dau	daut-da	65.71	48.10	1.52*

*** $p<0.001$
** $p<0.005$
* $p<0.01$

This set presents a very different picture from the last one. Although none of the HIT rates are very high (cf. HIT rate of 90% for reinforcement items) all of them have a HIT rate over 50%, which would indicate cohesiveness of the diphthongs themselves.

The long diphthongs have a higher HIT rate (66%) than the short, ingliding diphthongs (53%). The *d'* values for VVC are positive and significant, therefore the HIT rates are significantly greater than the FA rates. This indicates that there is a general cohesiveness of the long diphthong before a single obstruent. Subjects showed a slight preference for the separation of Vʌ (FAs higher that HITs), but this preference was not significant. The difference in cohesiveness between the two types of diphthongs, of course, is not unexpected, as the results from the Segment Count task described in Chapter 2 would indicate. In the Segment Count task subjects treated the long diphthongs, [au] and [ai], as single units 99% of the time and ingliding dipthongs, [uʌ, oʌ, eʌ, iʌ], as units only 67% of the time.

A comparison was also made among the long diphthongs, i.e., between those followed by a single obstruent (VVC), a nasal (VVNC) and a lateral (VVLC). In general the FA rates are all higher than expected.[92] (Note that VVC has the only FA rate among this set below 50%). If the two parts of the diphthong were absolutely cohesive as in English (Derwing et al., 1987), then one would expect much lower FA rates. The *d'* values for VVLC reached significance. However, the *d'* was negative, which means that the FAs were significantly greater than the HIT rates. Therefore, subjects generally preferred the separation of the long diphthong before /l/. Although both the HIT and FA rates for VVNC were high, the preference was for the non-separation of the diphthong, but this preference was not significant.

The results of a pairwise t-test are indicated in Table 54 below.

[92] The FA rate for reinforcement items was 10%.

Table 54. Statistical Significance (p<) of Relative Differences Among Long Diphthongs Followed by Single Obstruents or by Clusters with Postvocalic Resonants

	VVC [1.52]	VVNC [0.92]	[illegible]
VVC			
VVNC	ns		
VVLC	0.005	0.05	

[]=*d'* scores
ns= not significant (p>.05)

Long diphthongs followed by nasals or by obstruents are significantly more cohesive than long diphthongs followed by /l/. Given these results a cohesiveness scale could be set up as follows:

Figure 17: Cohesiveness Scale for Diphthongs

relative VV-cohesiveness

<———————————————

most   least

VVC, VVNC > VVLC

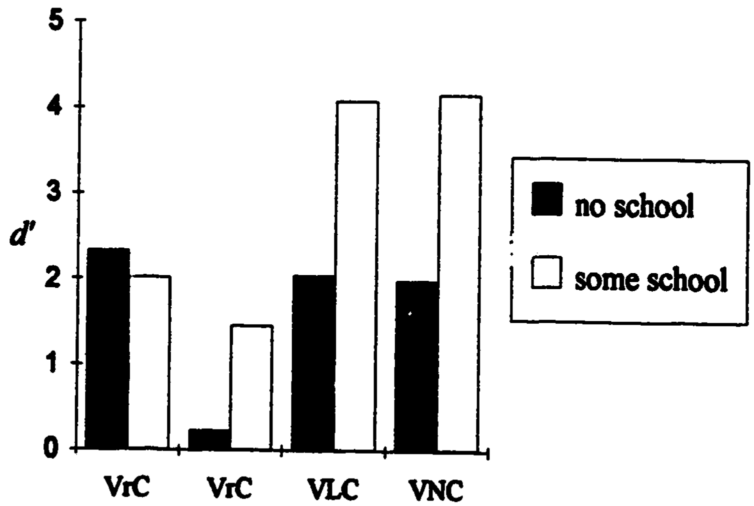
a) Subject Differences

A two-factor repeated measures ANOVA was run on 8 types of nuclei with 2 levels of age and 2 levels of German schooling. There was no significant difference between adults and children nor between those who had had no German schooling and those who had had some. Although there was no significant age-by-type interaction, there was a significant German schooling-by-type interaction.

(1) Effects of German Schooling

There are different stickiness trends for those who have had no High German instruction and those who have had some. In the figure below some of these differences can be seen.

Figure 18: <u>Final CCs with Postvocalic Resonants Type by German Schooling</u>



For those with no German schooling, V̄RC (which for these subjects has a *d'* of 0.22 [93]) is more V-sticky than VNC, VLC and V̆rC (which have *d'* values of 1.99, 2.04 and 2.33 respectively). For those with some German schooling, V̄rC and V̆rC are about equal in V-cohesiveness (*d*'s of 1.46 and 2.02) and are much more cohesive than VNC and VLC, which are also about equal in V-cohesiveness (*d'* of 4.16 and 4.09).

[93] In this case the low *d'* rate, which usually indicates V-stickiness, may be misleading as the subjects felt that (1) the inclusion of /r/ with the vowel and (2) the separation of V̄r leaving a tense vowel were both wrong. Here a low *d'* rate may just indicate two unacceptable choices.

Figure 19. <u>German Schooling Effects on Cohesiveness Scale for Postvocalic Resonants</u>

relative V-stickiness

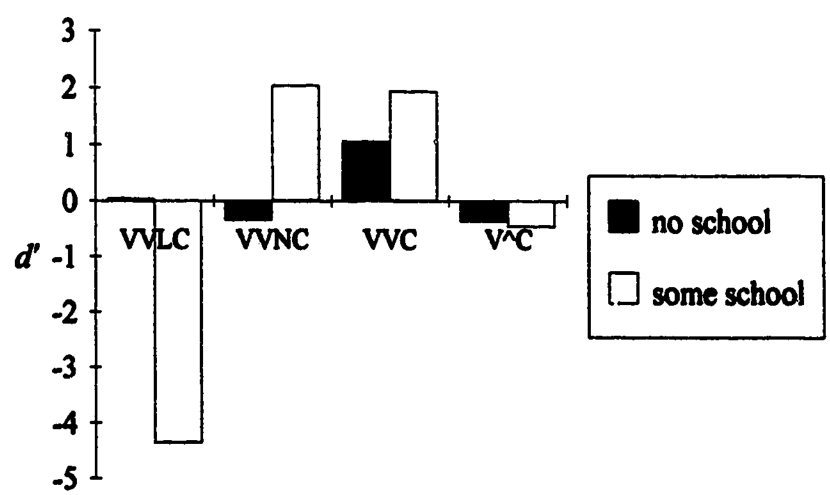
<——————————————

No School:	V̄rC < VNC, VLC, V̆rC
Some school:	V̄rC, V̆rC < VNC, VLC

Whereas those with no formal German training tended to group liquids and nasals with the vowel, it appears that those with some practice in reading and writing High German are better able to separate laterals and nasals from the preceding vowel.

For those with some German schooling and those with no German schooling the major difference in the separation of diphthongs appears to occur in those followed by /l/ (see figure below).

Figure 20: <u>Diphthongs Plus Final (C)C. Type by German Schooling</u>



In words like /bault/, the subjects who have attended German school will separate the first V from the second V of diphthongs before /l/. That is these subjects chose the deletion in word-pairs like /bault/-/ba/ but rejected /bault/-/bau/ much more often than those subjects who never attended German school. This could might be attributable to the fact that all the words with diphthongs followed by /l/ in this experiment have equivalents in High German with no diphthong. That is, a PD word like /bault/ 'soon' is /balt/ in High German. Those with some High German Schooling may be relying on the High German spelling (e.g., <bald>) for their decision and may feel that the second V of the diphthong, the /u/, is really part of a velarized /l/.

G. General Discussion

The findings of the three tasks have provided some insight into the cohesiveness of consonant and vowel clusters in PD. Vowel clusters in PD have traditionally been called diphthongs (Goerzen, 1972; Thiessen, 1963, 1976, 1977) and are considered to behave as units, while consonant clusters have not usually been given unit status. There has never been any real discussion in the literature of the possibility of affricates in PD; in fact, most of the traditional studies of PD never mention affricates (Thiessen, 1963; Mierau, 1965; Goerzen, 1972; Wiebe, 1983).[94] Due to the lack of knowledge about PD syllable structure, controversial segmentations, SF (potentially affricates), VV (potentially monosegmental vowel nuclei), and Cy (potentially bisegmental consonant plus glide) were included in the stimulus materials for the three tasks.

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[94] Only the studies by Mierau (1965) and Goerzen (1972) mention clusters at all, and these are just lists of all the possible linear combinations of vowels and consonants.

In the deletion-recognition tasks, it was found that obstruent clusters in the coda and onset were treated in like manners. In both initial and final position the fricative-stop clusters, /st/ and /št/, were most often treated as separable and least often treated as a unit. However, both /st/ and /št/ were more likely to be separated in the coda than in the onset. At the other end of the scale, /dž/ was the most often treated as a unit and the least often separated of all the obstruent clusters. The other clusters (all fricative-stops) occupy a place intermediate to the two extremes.

Traditionally, High German and many of the German dialects have been described as having the affricates /ts/ and /tš/. Word-initially /ts/ and /tš/ have very high FALSE ALARM rates (approximately 60%), so subjects find these to be acceptable as units in the onset. In fact, initial /tš/'s FALSE ALARM rate is higher than its HIT rate. So, /tš/ could be said to achieve monosegmental affricate status word initially in PD, with the possibility that /ts/ may also be a monosegmental affricate word initially. In word final position the FALSE ALARM rates for both /ts/ and /tš/ are lower than for those in initial position and significantly lower than their HIT rates. So perhaps subjects treat these affricates as single units in word-initial position but not in word-final position. This is very strange, but it may have an orthographic transfer basis. In English affricates like /dž/ and /tš/ are often spelled with an extra letter in final position as in <badge> and <patch>.[95]

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[95] The possibility remains that for some subjects these are monosegmental affricates and for others they are not. However, no significant individual variations were observed in the variables tested with repeated measures ANOVAs.

English, the second language of all the subjects and principle language of many of them, has the affricates /tš/ and /dž/. As we saw above, /tš/ may also occur in PD in word-initial position. The voiced affricate /dž/ presents some special problems, as its presence in PD in initial position is due to borrowing from English. If words containing /dž/ in initial position are borrowed from English, then the expected deletion pattern would be one where the entire affricate is deleted. To be sure, subjects liked this deletion 80% of the time (FAs mentioned above), which is higher than the separation of /dž/ (45%). It seems that subjects preferred to treat /dž/, as a unit which suggests it also is a monosegmental affricate in PD word initially. Word-finally, /dž/ is acceptable as a unit (60%), but was also acceptable as a sequence of separate entities (62%). So the status of /dž/ as a unit in final position is still unclear. All three affricates, /ts/, /tš/ and /dž/, were more likely to be treated as a unit in initial position than in final position. The tendency to separate these clusters in final position may be due to speakers' familiarity with the addition or deletion of fricatives in some English morphemes such as 3rd-person singlar, plurals and possessives. In fact, in both English and PD, subjects are used to adding and deleting sounds at the ends of words but not at the beginning. Therefore, it is seems reasonable that subjects would exhibit a greater ability to manipulate such word-final segments.

In Task B a solution was sought for dealing with palatal(ized) stops in PD. It was found that the two palatal(ized) stops, /k^y/ and /g^y/, were treated as units 65% of the time and were separated 75% of the time. Therefore, these could be seen as separable units which can also function as single units. Indeed, this is the very reason that /k^y/ and /g^y/ were not included in the final consonant deletion task (Task A). In the coda, the palatal component of these stops may or may not be present. That is, /k^y/ and /g^y/ are free to vary word-finally with /k/ and /g/, as in

/mailʸkʸ/ ~ /mailk/ 'milk'. Further, in initial position, /gʸ/ varies with /y/ initially, as in /gʸrʌit/ ~ /yrʌit/ 'Margaret'.[96] These, then, are separable units for which the stop component is optional initially and the glide is optional finally.

If it is the case that these palatalized stops are sometimes separate and sometimes not, then it calls into question the traditional analysis of all PD palatal(ized) consonants as non-sequential, non-complex phonemes (Mierau, 1965). This traditional analysis must be revised in light of the results from Task B, at least for the stops. The status of the other palatialized phonemes in PD, which are the lateral /lʸ/ and the nasal /nʸ/ (Wiebe, 1983) should also be examined. In the Segmentation Task (Chapter 2), 66% of the responses indicated segmentation of the palatalized nasal /nʸ/ into two parts in words like /hɛnʸʌ/ 'behind' and /ʌɪnʸn̩/ 'under'. This is further evidence for the optional separability of the palatalized phones in PD. It would seem that some of the phonemes in the palatal region are more complex units than originally thought.

In Tasks A and B, the inclusion of resonants in the onset and coda were examined. It has been suggested that resonants form part of the onset; for example, Derwing et al. (1987) found that English prevocalic resonants were grouped with the preceding consonants rather than with the vowel. In a comparison of initial CCR and final RCC, it was found here that resonants were more likely to form a unit with initial clusters than with final clusters. Thus, a resonant may form part of the onset in prevocalic position. In the Segmentation Task (Chapter 2) similar results were obtained.

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[96] Some authors (Goerzen, 1972) say that /kʸ/ and /gʸ/ are allophones of /k/ and /g/, while others (Mierau, 1965) say that /gʸ/ is a variant of both /y/ and /g/.

The coda deletion task (Task C) provided some insight into the nature of the nucleus. Specifically, it was noted that subjects found the ingliding diphthongs, Vʌ, slightly more acceptable separated than not (HITs 53%; FAs 60%).[97] Long diphthongs tend to form a cohesive unit before obstruents and nasals and less cohesive units before /l/. It could be said that a following /l/ somehow attracts the second part of the diphthong. These findings are similar to those discussed in Chapter 2. In the Segmentation Task, whereas long dipthongs were never separated, ingliding diphthongs were separated one third of the time. Again, the conclusion must be that diphthongs in PD do not form a uniformly cohesive unit. Some diphthongs have more internal cohesiveness than others and even very cohesive diphthongs can be pulled apart in certain environments.

In the coda deletion task, even though there was no significant difference between the postvocalic resonants (if we exclude V̄r from the set), postvocalic laterals and nasals were separated from the vowel more often than postvocalic /r/. In the Segment Count Task (Chapter 2) the same scale was found. Postvocalic liquids and nasals were also counted as sounds separate from the vowels more often than postvocalic /r/s were.

Previous studies have suggested a gradation of postvocalic stickiness. Derwing et al. (1987) found that, postvocalically, nasals were more C-sticky, that /l/ was more tightly bound to the vowel and /r/ even more so. Trieman (1984) found that nasals either formed a unit with final consonants or with the vowel, but

[97] One of the reasons that subjects may be separating Vʌ could be due to their knowledge of High German. Some of the stimuli containing this type of diphthong have cognates in High German (HG) and in English with a single vowel plus a postvocalic /r/, e.g., PD /vuʌt/ vs HG /vort/ 'word'; PD /šoʌp/ vs HG /šarf/ 'sharp'.

that postvocalic /r/ and /l/ formed a unit with the vowel. In a coda deletion task, Derwing et al. (1988) found that the pattern of postvocalic V-stickiness was N, /l/, /r/. Subjects found it extremely difficult to separate glides and /r/s from vowels, so Derwing et al. (1988) designated postvocalic glides and /r/ as absolutely V-sticky.[98] The results of the coda deletion task are consistent with the results of Treiman and of Derwing et al. (1987, 1988) for English, as it was found that in PD /r/ formed a unit more often with the vowel than nasals and laterals. Other than some variation due to diphthongs type and context, PD subjects also found the second V of long diphthongs (Derwing et al.'s glides) to be quite difficult to separate from the first vowel.

It was found that those subjects with some High German instruction behaved differently on the coda deletion-recognition than those with no High German instruction. Generally, there was more of a gradation in the separation of postvocalic resonants for subjects with German schooling than those with no German school background. Those with no German schooling treated VN, VL and Vr in a similar manner, but those with some German schooling were better able to separate laterals and nasals from the preceding vowel. In fact, the higher HIT rates of postvocalic liquids and nasals (where HIT means separation of vowel and resonant) were attributable to the subjects who had some German schooling. Before subjects have had any contact with spelling conventions for a German language, they are more likely to group postvocalic nasals with the preceding vowel.

[98] Significant negative *d'* was the criterion used for this designation.

After some instruction in High German, they tend to separate the vowel from the following nasal or lateral.[99]

A subject's German school attendance also affected their choice in word-pairs where the separation of diphthongs was involved. Subjects who attended High German classes more often chose to separate /ai/ and /au/ before /l/. (Their responses in the main contributed to the high FA rate of VVLC.) It has been suggested that familiarity with High German cognates, which all contain a single V before /l/ affected their choices. The differences between those with some German schooling and those with none may well be due to familiarity with the written form of a related dialect.

There were also significant differences due to age in the Final Consonant Deletion-Recognition Task (A). In this task adults separated final consonant clusters significantly more often than children. There seems to be a developmental trend in the recognition of separate sounds in final consonant clusters due, perhaps, to increased awareness of English inflectional morphemes. On the other hand, more exposure to the printed word in general (which adults presumably have) might lead to a greater ability to segment units such as consonant clusters into separate sounds. The difference between adults and children also may be ascribed to the reduced attention and motivation of the younger subjects. Thus, the developmental trend may be due to maturational and attentional factors, as well as increasing metalinguistic awareness which may, in part, be attributable to familiarity with the printed word.

[99] This parallels Read's (1986) findings that in invented spellings by children who are partially naive about standard English spelling, children tend to omit preconsonantal nasals in words like **bent**.

H. Conclusions

From the evidence presented above it could be said that onsets are composed of more or less cohesive complex segments. The most cohesive units were /tš/, /dž/ and /ts/, the traditional affricates in English and High German. A resonant following an initial consonant cluster will be more or less separate from either the intial cluster or the vowel. If there is any likelihood at all of a prevocalic resonant forming a unit, it will be with the preceding consonants. Obstruent clusters (except for /dž/) are less cohesive in the coda than in the onset. This separability is, perhaps, attributable to the general ability of bilingual English-PD speakers to add or remove obstruents due to the addition or subtraction of morphemes in word-final position (e.g., PD /vauš/ 'wash', /vaušt/ 'washed'; or English /mɪt/, /mɪts/). Long diphthongs (unless followed by /l/) form a more cohesive nucleus than ingliding diphthongs. Postvocalic resonants are more likely to be part of the nucleus than the coda, although they could shift between the two. Postvocalically, /r/ is more often part of the nucleus than /l/ or nasals, especially for those subjects with some High German schooling. Postvocalic resonants have more of a tendency to form part of the nucleus than prevocalic resonants.[100]

Vennemann (1988b) has proposed something called the offset as part of syllable structure, where the term refers to the final speech sound of a unit. Although Vennemann does not use the offset in quite this manner, perhaps

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[100] This is partly due to the nature of the resonants themselves in pre- and postvocalic positions: since /r/ is realized as a trill prevocalically and an English-like retroflex postvocalically, it is probably more vowel-like and thus more likely to form a unit with the vowel in postvocalic position. Similarly, /l/ is velarized in post vowel position and more likely to form a unit with a vowel than when it is not velarized, as in pre vowel position.

something like an offset could be proposed for resonants in PD. If a scalar bonding model of the syllable is used (Derwing, et al., 1987b and 1988), then the syllable in PD would consist of an onset with an offset, followed by a nucleus which also has an offset and finally a coda. The offsets (resonants) would be more likely to form a bond with the preceding unit, and the nucleus (+ offset) is more likely to bond with the coda to form a unit called the rime than it is to bond with the onset, as shown in the diagram below.

Figure 21: PD syllable structure

onset—offset ---- nucleus—offset ---- coda

Each of the major units is bound to its offset with a solid line to show that this bond is firmer than the ones indicated by the dashed line. This model allows for the possibility of the offsets to join with the following rather than the preceding units and with the addition of place markers (vertical lines below major units) would also allow for possibilities such as the separation of diphthongs in the nucleus and the attraction of part of the nucleus to the following offset (as in VVL).[101]

[101] Perhaps a better term than offset would be Venneman's term slope, so that other terms such as downslope and upslope or offslope and onslope could be used, but Vennemann has designated slope as something entirely different, which makes the term unsuitable.

IV. SUMMARY AND CONCLUSIONS

In order to achieve task independence, more than one technique was used to investigate the psychological reality of phonological units for speakers of PD. In general, results were corroborative across all tasks. Moreover, it seems that the deletion recognition task is something of an improvement over the deletion production tasks used by Morais et al. (1979) and Read et al. (1986) which proved difficult for most subjects.

The segment count experiment (Chapter 2) tested the ability of PD speakers to segment PD words into phonemes. It was suggested that if the ability to segment into phonemes is dependent on literacy in an alphabetic system (Read et al., 1986; Morais et al. 1979) then PD speakers, who are literate in English, should be able to segment words into phoneme-sized units, even though they are illiterate in their mother tongue. Further, it was reasoned, since PD has no orthographic system of its own, that orthographic interference observed in previous experiments with literate speakers (Jaeger, 80: Derwing & Nearey, 81; Dow, 1981; Derwing et al., 1986) would be less likely for PD speakers especially in a task conducted orally in PD. The experiment was designed to overcome previous difficulties with segment count tasks in verifying which units subjects were actually counting, except by inference from previously exhibited patterns (Dow, 1981, 1987). For this reason the entire experiment was tape-recorded and the tape-recorded version of subjects' responses was compared with the written record of their responses.

Subjects, who were trained to segment English words into segmental phonemes, displayed no difficulty with the training items. Nevertheless, the units into which subjects segmented PD words did not always correspond to phonemes, but were sometimes subsyllabic units larger than the phoneme. Some general segmentation patterns emerged which suggested that the environment of the unit as well as the composition and complexity of the syllable affected subjects' segmentation abilities.

It was observed that prevocalic resonants were more V-sticky (16%) than C-sticky (5%). However, the greater tendency was to treat prevocalic resonants as separate units, rather than part of the onset or the nucleus. Postvocalic resonants displayed an even stronger tendency to be more V-sticky (44%) than C-sticky (3%) and even though postvocalic resonants were more often treated as separate units, the likelihood of them forming part of the nucleus was much greater than them forming part of the coda.

It was noted that the embedding of pre- and postvocalic resonants affects their V-stickiness, that is, increases the likelihood of the resonant to form part of the nucleus. An initial resonant formed a cohesive unit with the vowel (2% cohesiveness) less often than a resonant preceded by a single consonant (16%) or by two consonants (32%). Similarly, word-final postvocalic resonants less often formed a unit with the vowel (24%) than when they were followed by a single consonant (41%) or a consonant cluster (54%). Thus, it appears that the more embedded a resonant is the greater tendency it has to form a unit with the vowel.

Due to the nature of PD diphthongs, in this analysis they were treated as a sequence of two vowels. Long diphthongs (VV) and short outgliding diphthongs (ʌV) formed very cohesive units (97% and 99% respectively). Ingliding diphthongs (Vʌ) displayed far less cohesiveness (67%) than either of the other two types of diphthongs. Further, word-final Vʌ was less cohesive (16%) than when it was followed by a single consonant (56%) or a consonant cluster (84%). It seems that whether or not Vʌ was treated as a sequence of two vowels or as a single unit depended on its embeddedness in the syllable. In this regard Vʌ behaves more like a vowel plus resonant sequence than like the other diphthongs and it displays similar cohesiveness to vowels plus resonants overall (Vʌ, 67% cohesiveness and VR, 62%).

It was proposed that PD has three types of nuclei. The diphthongs VV and ʌV form one type of nucleus (98% cohesiveness), vowels plus /ʌ/ and /r/, the second type (65%) and vowels followed by laterals and nasals, the third (27%). The gradualness of these results is similar to that observed by Derwing et al. (1987).

In the segment count task the cohesiveness of initial and final consonant clusters was also under investigation. Overall, initial consonant clusters were no more cohesive than final clusters (overall 41% cohesiveness for both). The affricate /ts/ which demonstrated a remarkably different cohesiveness pattern to the other stop-fricatives, was much more cohesive both initially (85%) and finally (59%) than the other obstruent clusters. It appears that /ts/ should be treated as a monosegmental affricate, especially in syllable-initial position. The palatal consonants were virtually inseparable initially and finally (99% cohesion) and, were it not for the fact that medial /kʸ/ and /nʸ/ were separated 24% and [illegible] of the time, these would also appear to be monosegmental units. Therefore, the position of the phonological unit, whether it is an obstruent cluster or a supposedly single-segment palatal consonant affects its cohesiveness.

The results of the spelling task generally corroborated the segmentation task. Overall, 11% of the subjects used a single spelling for vowel plus pre- and postvocalic /r/, 5% for vowel plus pre- and postvocalic /l/ and only 1% for vowel plus nasal in both pre- and post-vowel positions. This would support the segmentation task V-stickiness hierarchy of r > L,N.

An examination of the spellings from the subset of subjects who treated rV and Vr as a single segment in the Segmentation Task suggested that subjects might have adopted spellings from English or German, as 96% of these cohesive vowel + /r/s and /r/ + vowels were spelled with two letters. The spelling of diphthongs presents a different picture from the resonants. Cohesive diphthongs (those which were treated as a single unit in the segmentation task) were written with one letter 56% of the time, whereas cohesive vowels and resonants (both VR and RV) were only written with one letter 4% of the time. This could mean that subjects who treated pre- and postvocalic resonant-vowel combinations as a unit in a segmentation task were more likely to adopt a digraph strategy for vowels plus resonants than for diphthongs in the spelling task, or that subjects were able to further analyze vowels and resonants into two units during a spelling task.

Obstruent clusters which were treated as single units by some subjects were more likely to be written with one letter in initial position (15%) than in final position (9%) by these subjects. For these few subjects, then, it appears that these are truly single units. Cohesive /ts/ was most often spelled with a single letter in both positions but particularly word-initially (finally, 27% vs. initially, 92%). The single-letter spelling of /ts/ supports the monosegmental treatment of /ts/ in the segmentation task, particularly in word-initial position. Palatals, which were more often treated as single units in initial and final, than in medial position, were also more often spelled with a single letter both initially and finally than medially.

It appears that PD speakers, unlike speakers who are not literate in an alphabetic system (see Read et al. 1986, Derwing, et al. 1990), can segment words into units smaller than the syllable. This is not unexpected, as PD speakers are literate in an alphabetic system. However, the PD subjects tested did not always segment words into individual phonemes, even though it was previously thought the phonemes were readily accessible to adults literate in an alphabetic system. Although there was evidence of segmentations into subsyllabic units which corresponded to onset, nucleus and coda, it appears the constituency of these units fluctuates depending on their composition and their environment. Thus, both the primacy of the phoneme even for adult speakers literate in an alphabetic system and the widely accepted hierarchical model of the syllable which presupposes rigid boundaries between subsyllabic units appear to be questionable. A more acceptable model for PD syllables would be a scalar bonding model (Derwing et al., 1987), which allows for fluctuations between units and does not necessarily dictate that any division of the syllable must culminate in individual phonemes.

In order to investigate the constituency of subsyllabic units further using a full range of consonant clusters, diphthongs and vowel-resonant possibilities, a more systematic method of testing based on Derwing, Nearey and Dow's (1987) deletion-recognition tasks was employed. Using signal detection procedures, a measure of detectability of a pattern designated to be "nominally correct", a *d'* score, was calculated as a function of HITs, MISSes, FALSE ALARMs and CORRECT REJECTIONs. For both the initial and final consonant deletion tasks a high positive *d'* value is an indication of the non-cohesiveness or separability of consonant clusters. In both tasks the obstruent clusters displayed similar patterns. It was found that in both word-initial and word-final position fricative-stop clusters were less cohesive than stop-fricative clusters. It was also noted that of the obstruent clusters both initially and finally /dž/ was most cohesive, with a greater likelihood of being treated as a unit.

There was some indication that the order of elements in the syllable and their environment affects the separability of consonant clusters. Final /st/ clusters were significantly less cohesive than final /ts/ clusters. This is not unexpected as the Segment Count task suggested that subjects were treating /ts/as a monosegmental affricate. Further, in the Final Consonant Deletion-Recognition task, if /st/ or /ts/ was preceded by a vowel, then the FALSE ALARM rates were lower (19% and 23% respectively) than if they were preceded by a resonant consonant (27% and 54%).

A difference was also observed in the cohesiveness of initial and final obstruent clusters. Obstruent clusters were generally more cohesive initially than finally. Word-initial clusters containing resonants, (C)CR, were found to be more cohesive than final RC(C). Perhaps this is due to the fact that postvocalic resonants are more V-sticky and thus less likely to form a unit with the final consonant (cluster) while prevocalic resonants are more C-sticky and more likely to form a unit with initial consonant(s). This is consistent with Derwing et al.'s 1987b findings.

The palatal consonants /k^y/ and /g^y/ (C^y), traditionally thought to be segmental phonemes, had higher *d'* rates than the initial stop-fricative clusters, /ts/, /tš/ and /dž/, in some analyses also treated as single-segment affricates. That is to say, in the initial consonant deletion task, word-initial affricates were more often treated as a unit and less often separated than initial C^y. Thus, there is a gradation of separability even in so-called monosegmental units.

The separability of palatal consonants was not affected by their immediate environment. They had similar *d'* rates whether they were followed by a vowel or a resonant. Even though the HIT rates of C^y were significantly higher than the FALSE ALARM rates, the FALSE ALARM rates were very high (65%), which suggests that many subjects were equally comfortable with separating the stop component from the palatal component as with treating them as a unit. This, coupled with the results from the Segment Count task, where word position affected the separability of C^y (/k^y/ was separated more often in medial position), calls for a re-evaluation of palatal consonants as monsegmental units.

In the Coda Deletion task, a high *d′* rate was either an indication of the separability of the postvocalic resonant from the preceding vowel or of the lack of cohesiveness of the vowel cluster or diphthong. As in the Segmentation Task it was found that ingliding diphthongs (Vʌ) were less cohesive than long diphthongs (VV). Whether or not the diphthong was followed by a single consonant or a resonant plus consonant also affected its separability. As in the Segment Count task, the more embedded a diphthong is the more cohesive it is. The hierarchy of separability of postvocalic resonants observed in the Segment Count task was also noted in the Coda Deletion-Recognition task. The HIT rates of the VL (76%) and VN (74%) were higher than that of Vr (64%), which means subjects preferred the separation of laterals and nasals from the vowel over that of /r/ from the vowel.

The results of the Segment Count and Deletion Recognition Tasks indicate that both syllable position and complexity affect the cohesiveness of subsyllabic units, and that phonetically complex units such as affricates, palatal consonants and ingliding diphthongs, are not necessarily treated as monosegmental. Again their cohesiveness depends on their environment. In light of these results, it would appear that a model of the syllable which implies a clear delineation between subsyllabic units, such as a hierarchical model, would be inadequate to describe a PD syllable. To date, the only viable model is one of the scalar-bonding type in which the bond strengths among the elements that make up the syllable are permitted to vary depending both on the quality of the segment involved and the overall complexity of the syllable.

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APPENDICES

APPENDIX I:

Responses to Segment Count Task

No.	Item	Gloss[1]		Predicted	% Correct	Most Frequent
		English	German	Count	Responses	Counts[2]
1.	/vrωk/	turnip	Rübe	4	60%	4 (60%)
2.	/dɛrç/	through	durch	4	36%	3 (64%)
3.	/g^{y}mʌɪnt/	congregation	Gemeinde	6	19%	4 (56%)
4.	/kɔlt/	cold	kalt	4	60%	4 (60%)
5.	/frauts/	funny face	Fratze	6	8%	4 (64%)
6.	/rɛlps/	belch	Rülps	5	28%	4 (48%)
7.	/g^{y}rʌɪn/	green	grün	5	4%	4 (60%)
8.	/pɛlts/	fur, pelt	Pelz	5	20%	5 (40%); 4 (40%)
9.	/vuʌt/	word	Wort	4	24%	3 (64%)
10.	/šplet/	laugh	lach	5	40%	5 (40%); 4 (36%)
11.	/braiv/	letter, brief	Brief	5	8%	4 (68%)
12.	/k^{y}ast/	wedding	Kost	4	88%	4 (88%)
13.	/fɔrmʌ/	farmer	Farmer	5	44%	5 (44%); 4 (40%)
14.	/vaç/	away	weg	3	84%	3 (84%)
15.	/nækš/	stubborn	hartnäckig	4	56%	4 (56%); 3 (44%)
16.	/faržž/	verses	Versen	4	48%	4 (48%); 3 (48%)
17.	/šlüt/	lock	Schlüßel	4	72%	4 (72%)
18.	/darp/	villager	Dorf	4	44%	3 (52%)
19.	/plüts/	innards, placenta	Plazenta	5	36%	4 (52%)

[1] Whenever possible a similar or cognate form has been given for the **English** or German gloss. In some instances, the German gloss is not the most common form (e.g., No. 13, **Farmer** is much less common than **Bauern**) rather it is the most similar form . Sometimes a cognate is supplied which is not necessarily a direct translation (e.g., No. 8, **/pɛlts/** means **fur**, yet the more similar **pelt** is also included in the gloss).

[2] Percentage of subjects responding with a particular count (number of speech sounds) is given in brackets.

No.	Item	Gloss		Predicted	% Correct	Most Frequent
		English	German	Count	Responses	Counts
20.	/höʌx/	high	hoch	4	24%	3 (56%)
21.	/pɷnt/	pound	Pfund	4	72%	4 (72%)
22.	/tsɪpl̩/	onion	Zwiebel	5	16%	4 (56%)
23.	/fiʌt/	drives	fährt	4	44%	3 (52%)
24.	/gʸlaiz/	track	Gleis	5	0%	4 (80%)
25.	/bʌolt/	soon	bald	5	8%	4 (72%)
26.	/blɪts/	lightening	Blitz	5	44%	4 (48%)
27.	/šrɛt/	step	Schritt	4	68%	4 (68%)
28.	/kʸned/	knead	knet	4	72%	4 (72%)
29.	/hɛŋkst/	stallion	Hengst	6	8%	4 (60%)
30.	/harx/	listen, hark	horch	4	44%	3 (52%)
31.	/kʸɪnt/	child	Kind	4	52%	4 (52%); 3 (44%)
32.	/tvalv/	twelve	tvalv	5	44%	5 (44%); 4 (44%)
33.	/traçt/	carries	tragt	5	40%	4 (48%)
34.	/gaunz/	goose	Gans	5	8%	4 (64%)
35.	/gʸnɔr/	grumble	gnatz	4	56%	4 (56%); 3 (44%)
36.	/tsveʌkʸ/	purpose	Zweck	6	0%	4 (68%)
37.	/glɔmz/	cottage cheese	Quark	5	48%	5 (48%); 4 (40%)
38.	/fʌɪt/	feet	Füße	4	0%	3 (88%)
39.	/haults/	throat	Hals	6	0%	4 (48%); 3 (40%)
40.	/kʸɔrš/	cherry	Kirsch	4	32%	3 (68%)
41.	/grʌɔt/	great	groß	5	0%	4 (64%)
42.	/mailʸkʸ/	milk	Milch	5	0%	4 (56%); 3 (40%)
43.	/hɛnʸʌ/	behind	hinter	4	28%	3 (40%)
44.	/ʌɪnʸn/	under	Unten	4	32%	3 (44%)
45.	/præsn̩/	pressing	pressen	5	52%	5 (52%)
46.	/kʸaršt/	crust	Kruste	5	28%	4 (60%)
47.	/gnɪ̨pl̩/	gristle	Knorpel	5	52%	5 (52%); 3 (24%)
48.	/glɔts/	stare	glotz	5	40%	4 (52%)
49.	/miʌšt/	most	meist	5	8%	4 (76%)

No.	Item	Gloss		Predicted	% Correct	Most Frequent
		English	German	Count	Responses	Counts
50.	/jelts/	yolk	gelb	5	16%	4 (64%)
51.	/jωñk^{y}ʌ/	youngster (m)	Junge	5	28%	3 (32%); 4 (24%)
52.	/bitsl̩/	bee sting	Biß	5	32%	4 (48%)
53.	/g^{y}rʌɪt/	Greta	Gretel	5	8%	4 (60%)
54.	/dræšn̩/	thrashing	dreschen	5	56%	5 (56%); 4 (36%)
55.	/fuʌ/	drove	fuhr	3	84%	3 (84%)
56.	/gr̩k^y/	cucumber	Gurke	3	56%	3 (56%); 4 (40%)
57.	/kaulf/	calf	Kalb	5	0%	4 (60%); 3 (36%)
58.	/k^{y}veʌk^y/	quack grass	Quecke	5	4%	4 (68%)
59.	/štrɛml̩/	strip	Strieme	6	16%	5 (36%); 4 (36%)
60.	/küʌkn̩/	cookies	Kuchen	5	20%	4 (52%)
61.	/lωtš/	soother	Lutscher	4	55%	4 (55%); 3 (32%)
62.	/g^{y}müz/	vegetable	Gemüse	4	33%	4 (55%)

APPENDIX II

TASK A. FINAL CONSONANT DELETION RECOGNITION TRAINING, REINFORCEMENT AND TEST ITEMS

Training Items

TR1. /dωps/ - /dωp/

TR2. /šlωfs/ - /šlωf/

TR3. /lɔft/ - /lɔf/

TR4. /naχt/ - /naχ/

TR5. /glωks/ - /glωk/

TR6. /raçt/ - /raç/

TR7. /štɪft/ - /štɪf/

TR8. /blʌɪfs/ - /blʌɪf/

TR9. /lʌɔps/ - /lʌɔp/

TR10. /šlæçt/ - /šlæç/

Practice Items

PR1. /šæps/ - /šæp/ (**YES**)

PR2. /frωçt/ - /frω/ (NO: /frωçt/--/frωç/)

PR3. /daks/ - /dak/ (**YES**)

PR4. /fɛft/ - /fɛ/ (NO:/fɛft/--/fɛf/)

PR5. /prɪps/ - /prɪ/ (NO:/prɪps/--/prɪp/)

PR6. /traçt/ - /traç/ (**YES**)

Appendix II: Final Consonant Deletion Recognition

Reinforcement Items

R1. /dωps/ - /dωp/
R2. /šlωfs/ - /šlωf/
R3. /lɔft/ - /lɔf/
R4. /naχ/ - /naχ/
R5. /glωks/ - /glωk/
R6. /raçt/ - /raç/
R7. /štɪft/ - /štɪf/
R8. /blʌɪfs/ - /blʌɪf/
R9. /lʌɔps/ - /lʌɔp/
R10. /šlæçt/ - /šlæç/
R11. /šæps/ - /šæp/
R12. /frωçt/ - /frωç/
R13. /daks/ - /dak/
R14. /fɛft/ - /fɛf/
R15. /prɪps/ - /prɪp/
R16. /trayçt/ - /trayç/
R17. /klaks/ - /klak/

Test Items

1. /ditš/ - /dit/
2. /ditš/ - /di/
3. /lωtš/ - /lωt/
4. /lωtš/ - /lω/
5. /štʌɪtš/ - /štʌɪt/
6. /štʌɪtš/ - /štʌɪ/
7. /vrɛntš/ - /vrɛnt/
8. /vrɛntš/ - /vrɛn/
9. /vrɛntš/ - /vrɛ/
10. /bωkš/ - /bωk/
11. /bωkš/ - /bω/
12. /nækš/ - /næk/
13. /nækš/ - /næ/
14. /paukš/ - /pauk/
15. /paukš/ - /pau/
16. /šmɛŋkš/ - /šmɛŋk/
17. /šmɛŋkš/ - /šmɛŋ/
18. /šmɛŋkš/ - /šmɛ/
19. /nωšt/ - /nωš/
20. /nωšt/ - /nω/
21. /vɔšt/ - /vɔš/
22. /vɔšt/ - /vɔ/
23. /miʌšt/ - /miʌš/
24. /miʌšt/ - /miʌ/
25. /miʌšt/ - /mi/
26. /daršt/ - /darš/
27. /daršt/ - /dar/
29. /daršt/ - /da/
30. /mɛts/ - /mɛt/
31. /mɛts/ - /mɛ/
32. /plüts/ - /plüt/
33. /plüts/ - /plü/

34. /frots/ - /frot/
35. /frots/ - /fro/
36. /krauts/ - /kraut/
37. /krauts/ - /krau/
39. /krauts/ - /kra/
40. /jelts/ - /jelt/
41. /jelts/ - /jel/
42. /jelts/ - /je/
43. /kɔrts/ - /kɔrt/
44. /kɔrts/ - /kɔr/
45. /kɔrts/ - /kɔ/
46. /grωnts/ - /grωnt/
47. /grωnts/ - /grωn/
48. /grωnts/ - /grω/
49. /haults/ - /hault/
50. /haults/ - /haul/
51. /haults/ - /hau/
52. /haults/ - /ha/
53. /k^yast/ - /k^yas/
54. /k^yast/ - /k^ya/
55. /brost/ - /bros/
56. /brost/ - /bro/
57. /lɔst/ - /lɔs/
58. /lɔst/ - /lɔ/
59. /vaiçt/ - /vaiç/
60. /vaiçt/ - /vai/
61. /vaiçt/ - /va/
62. /tšarst/ - /tšars/
63. /tšarst/ - /tšar/
64. /tšarst/ - /tša/
65. /vuʌst/ - /vuʌs/
66. /vuʌst/ - /vuʌ/
67. /vuʌst/ - /vu/
68. /dɔnst/ - /dɔns/
69. /dɔnst/ - /dɔn/
70. /haηkst/ - /haηks/
71. /haηkst/ - /haηk/
72. /haηkst/ - /haη/
73. /fωηkst/ - /fωηks/
74. /fωηkst/ - /fωηk/
75. /fωηkst/ - /fωη/
76. /žɛrdž/ - /žɛrd/
77. /žɛrdž/ - /žɛr/
78. /foʌdž/ - /foʌd/
79. /foʌdž/ - /foʌ/
80. /foʌdž/ - /fo/

Appendix II

TASK B: INITIAL CONSONANT DELETION RECOGNITION TRAINING, REINFORCEMENT AND TEST ITEMS

Training Items

TR1. /tvalv/ - /valv/

TR2. /špωk/ - /pωk/

TR3. /tit/ - /it/

TR4. /kvark/ - /vark/

TR5. /skold/ - /kold/

TR6. /šplet/ - /plet/

TR7. /vɪnt/ - /ɪnt/

TR8. /škʌɔp/ - /kʌɔp/

TR9. /tvoʌš/ - /voʌš/

TR10. /šɛf/ - /ɛf/

Practice Items

PR1. /švin/ - /vin/ (**YES**)

PR2. /dvol/ - /ol/ (NO:/dvol/ - /vol/)

PR3. /tvaŋk/ - /vaŋk/ (**YES**)

PR4. /šprɛts/ - /rɛts/ (NO:/šprɛts/ - /prɛts/)

PR5. /skʌɔlt/ - /ʌɔlt/ (NO:/skʌɔlt/--/kʌɔlt/)

PR6. /špωk/ - /pωk/ (**YES**)

Appendix II: Initial Consonant Deletion

Reinforcement Items

R1. /tvalv/ - /valv/

R2. /špωk/ - /pωk/

R3. /tit/ - /it/

R4. /kvark/ - /vark/

R5. /skold/ - /kold/

R6. /šplet/ - /plet/

R7. /vɪnt/ - /ɪnt/

R8. /škʌɔp/ - /kʌɔp/

R9. /tvoʌš/ - /voʌš/

R10. /šɛf/ - /ɛf/

R11. /švin/ - /vin/

R12. /dvol/ - /vol/

R13. /tvaŋk/ - /vaŋk/

R14. /šprɛts/ - /prɛts/)

R15. /skʌɔlt/ - /kʌɔlt/

R16. /špωk/ - /pωk/

R17. /kvɔl/ - /vɔl/

Test Items

1. /prɔš/ - /rɔš/
2. /prɔš/ - /ɔš/
3. /grʌɔt/ - /rʌɔt/
4. /grʌɔt/ - /ʌɔt/
5. /klωk/ - /lωk/
6. /klωk/ - /ωk/
7. /šlont/ - /lont/
8. /šlont/ - /ont/
9. /šnet/ - /net/
10. /šnet/ - /et/
11. /šmɔk/ - /mɔk/
12. /šmɔk/ - /ɔk/
13. /kʸnip/ - /ynip/
14. /kʸnip/ - /nip/
15. /kʸnip/ - /ip/
16. /kʸam/ - /yam/
17. /kʸam/ - /am/
18. /kʸis/ - /yis/
19. /kʸis/ - /is/
20. /kʸnɪps/ - /ynɪps/
21. /kʸnɪps/ - /nɪps/
22. /kʸnɪps/ - /ɪps/
23. /kʸriz/ - /yriz/
24. /kʸriz/ - /riz/
25. /kʸriz/ - /iz/
26. /kʸlʌɪd/ - /ylʌɪd/
27. /kʸlʌɪd/ - /lʌɪd/
28. /kʸlʌɪd/ - /ʌɪd/
29. /gʸɛn/ - /yɛn/
30. /gʸɛn/ - /ɛn/
31. /gʸels/ - /yels/

32. /gʸels/ - /els/
33. /gʸrʌɪn/ - /yrʌɪn/
34. /gʸrʌɪn/ - /rʌɪn/
35. /gʸrʌɪn/ - /ʌɪn/
36. /gʸnɔr/ - /ynɔr/
37. /gʸnɔr/ - /nɔr/
38. /gʸnɔr/ - /ɔr/
39. /gʸnɽpl/ - /ynɽpl/
40. /gʸnɽpl/ - /nɽpl/
41. /gʸnɽpl/ - /ɽpl/
42. /gʸlad/ - /ylad/
43. /gʸlad/ - /lad/
44. /gʸlad/ - /ad/
45. /štæp/ - /tæp/
46. /štæp/ - /æp/
47. /štræŋk/ - /træŋk/
48. /štræŋk/ - /ræŋk/
49. /štræŋk/ - /æŋk/
50. /štrüf/ - /trüf/
51. /štrüf/ - /rüf/
52. /štrüf/ - /üf/
53. /štrol/ - /trol/
54. /štrol/ - /rol/
55. /štrol/ - /ol/
56. /stʌɪv/ - /tʌɪv/
57. /stʌɪv/ - /ʌɪv/
58. /stuʌ/ - /tuʌ/
59. /stuʌ/ - /uʌ/
60. /tšɔrt/ - /šɔrt/
61. /tšɔrt/ - /ɔrt/
62. /tšɛk/ - /šɛk/
63. /tšɛk/ - /ɛk/
64. /tsʌɪz/ - /sʌɪz/
65. /tsʌɪz/ - /ʌɪz/
66. /tsap/ - /sap/
67. /tsap/ - /ap/
68. /tsɪpl/ - /sɪpl/
69. /tsɪpl/ - /ɪpl/
70. /džɔmp/ - /žɔmp/
71. /džɔmp/ - /ɔmp/
72. /džak/ - /žak/
73. /džak/ - /ak/

Appendix II

TASK C: CODA DELETION RECOGNITION TRAINING, REINFORCEMENT AND TEST ITEMS

Training Items

TR1. /dωps/ - /dω/

TR2. /šlωfs/ - /šlω/

TR3. /lɔft/ - /lɔ/

TR4. /naχt/ - /na/

TR5. /glωks/ - /glω/

TR6. /raçt/ - /ra/

TR7. /štɪft/ - /štɪ/

TR8. /blʌɪfs/ - /blʌɪ/

TR9. /japs/ - /ja/

TR10. /šlæçt/ - /šlæ/

Practice Items

PR1. /šæps/ - /šæ/ (YES)

PR2. /frωçt/ - /frωç/ (NO: /frωçt/--/frω/)

PR3. /daks/ - /da/ (YES)

PR4. /fɛft/ - /fɛf/ (NO:/fɛft/--/fɛ/)

PR5. /prɪps/ - /prɪp/ (NO:/prɪps/--/prɪ/)

PR6. /traçt/ - /traç/ (YES)

PR6. /brɔχt/ - /brɔ/ (YES)

Appendix II: Coda Deletion Recognition

Reinforcement Items

R1. /dωps/ - /dω/

R2. /šlωfs/ - /šlω/

R3. /lɔft/ - /lɔ/

R4. /naχ/ - /na/

R5. /glωks/ - /glω/

R6. /raçt/ - /ra/

R7. /štɩft/ - /štɩ/

R8. /blɩfs/ - /blɩ/

R9. /japs/ - /ja/

R10. /šlæçt/ - /šlæ/

R11. /šæps/ - /šæ/

R12. /frωçt/ - /frω/

R13. /daks/ - /da/

R14. /fɛft/ - /fɛ/

R15. /prɩps/ - /prɩ/

R16. /brɔχt/ - /brɔ/

R17. /klaks/ - /kla/

Test Items

1. /daut/ - /dau/
2. /daut/ - /da/
3. /štauk/ - /štau/
4. /štauk/ - /šta/
5. /kaup/ - /kau/
6. /kaup/ - /ka/
7. /vauš/ - /vau/
8. /vauš/ - /va/
9. /vaid/ - /vai/
10. /vaid/ - /va/
11. /bait/ - /bai/
12. /bait/ - /ba/
13. /gʸlaiz/ - /gʸlai/
14. /gʸlaiz/ - /gʸla/
15. /štuʌk/ - /štuʌ/
16. /štuʌk/ - /štu/
17. /vuʌt/ - /vuʌ/
18. /vuʌt/ - /vu/
19. /šoʌp/ - /šoʌ/
20. /šoʌp/ - /šo/
21. /hoʌk/ - /hoʌ/
22. /hoʌk/ - /ho/
23. /diʌk/ - /diʌ/
24. /diʌk/ - /di/
25. /piʌt/ - /piʌ/
26. /piʌt/ - /pi/
27. /veʌk/ - /veʌ/

28. /veʌk/ - /ve/
29. /šveʌf/ - /šveʌ/
30. /šveʌf/ - /šve/
31. /farž/ - /far/
32. /farž/ - /fa/
33. /dɛrc/ - /dɛr/
34. /dɛrc/ - /dɛ/
35. /dɛrc/ - /de/
36. /k^{y}ɔrš/ - /k^{y}ɔr/
37. /k^{y}ɔrš/ - /k^{y}ɔ/
38. /k^{y}ɔrš/ - /k^{y}o/
39. /gr̩k/ - /gr̩/
40. /gr̩k/ - /gɷ/
41. /gr̩k/ - /gu/
42. /vɪrp/ - /vɪr/
43. /vɪrp/ - /vɪ/
44. /vɪrp/ - /vi/
45. /nɷrs/ - /nɷr/
46. /nɷrs/ - /nɷ/
47. /nɷrs/ - /nu/
48. /gaunz/ - /gaun/
49. /gaunz/ - /gau/
50. /gaunz/ - /ga/
51. /zɛnz/ - /zɛn/
52. /zɛnz/ - /zɛ/
53. /bɔlš/ - /bɔl/
54. /bɔlš/ - /bɔ/
55. /bɔlš/ - /bo/
56. /mail^{y}k^{y}/ - /mail^{y}/
57. /mail^{y}k^{y}/ - /mai/
58. /mail^{y}k^{y}/ - /ma/
59. /bault/ - /baul/
60. /bault/ - /bau/
61. /bault/ - /ba/
62. /kaulf/ - /kaul/
63. /kaulf/ - /kau/
64. /kaulf/ - /ka/
65. /rɪŋk/ - /rɪŋ/
66. /rɪŋk/ - /rɪ/
67. /kraŋk/ - /kraŋ/
68. /kraŋk/ - /kra/
69. /fɷŋk/ - /fɷŋ/
70. /fɷŋk/ - /fɷ/
71. /glɔmz/ - /glɔm/
72. /glɔmz/ - /glɔ/
73. /štræmp/ - /štræm/
74. /štræmp/ - /štræ/
75. /laump/ - /laum/
76. /laump/ - /lau/
77. /laump/ - /la/

APPENDIX III:
PLAUTDIETSCH CONSONANTS AND VOWELS
(from Wiebe, 1983)

Table 55. PD Consonants

		bilabial	labio-dental	alveolar	palato-alveolar	palatal	velar	glottal
stops	vl.	p		t		k^y	k	?
	vd.	b		d		g^y	g	
fricatives	vl.		f	s	š	ç	x	h
	vd.		v	z	ž			
affricates	vl.			ts	tš			
	vd.				dž			
nasals		m		n		n^y	ŋ	
liquids				l[1]		l^y		
				r[2]				
glide						y		

Table 56. PD Vowels

		front		central	back
		unrounded	rounded		
high	tense	i	ü		u
	lax	I			ω
mid	tense	e	ö	ɼ	o
	lax	ɛ		ʌ	ɔ
low		æ		a	

Table 57. Diphthongs

Long	Outgliding	Ingliding :
ai, au	ʌI, ʌɔ	iʌ, üʌ, eʌ, öʌ, oʌ, uʌ

[1] /l/ [ɫ] / V___
[illegible]

[2] /r/ [r̄] / {C,#}___V
[ř] / V___V
[r] ("English r")