THE EFFECT OF LINGUISTIC INPUT ON CHILDREN'S PHONOLOGICAL AWARENESS: A CROSS-LINGUISTIC STUDY

Marketa Caravolas
Department of Educational Psychology
McGill University

A thesis submitted to the
Faculty of Graduate Studies and Research
in partial fulfilment of the requirements for the
degree of Master of Arts

Montréal, Québec

Abstract

The aim of this study was to examine the effect of oral language input on the development of phonological awareness in children. Specifically, children's awareness of syllabic onsets was assessed using several phonological awareness tasks as well as a spelling task. The subjects of the study were kindergarten and first grade speakers of Czech and English. The Czech language contains a considerably higher frequency and variety of complex syllabic onsets than English. Hence, it was hypothesized that if linguistic input affects children's phonological awareness development, Czech children should show higher levels of ability on the tasks. These differences were expected to appear in preliterate kindergarten children if linguistic input, more than literacy and/or general cognitive factors, impacts significantly on phonological awareness.

The results revealed that Czech children do possess higher levels of awareness than English-Canadian children. The Czech children performed better on two of the phonological awareness tasks as well as on the spelling task. The groups did not differ on one task. The English children found the manipulation of word-initial phonemes in cluster onsets more difficult than the Czech children but the groups fared equally well on single-phoneme onsets. Differences were observed among the kindergarten children, and dramatic differences occurred in grade one. The spelling test further revealed that Czech children were not only better able to represent complex onsets in their spellings but were generally at a more advanced stage of spelling development.

The finding that preliterate Czech children were more advanced in the ability to manipulate complex syllable onsets suggests that oral language input has an important effect on developing phonological awareness skills. Furthermore, its effect appears to be independent of the effects of literacy. The results of the first grade children indicate that

Czech chiidren have at least a two-year advantage over English-speaking children in manipulating cluster onsets. This higher level of awareness is reflected in their spellings which suggests that linguistic input has positive effects on the acquisition of literacy skills as well as on phonological awareness.

Résumé

Le but de cette recherche était d'examiner l'effet de l'input oral sur le développement de la sensibilité phonologique chez l'enfant. Plus particulièrement, la sensibilité aux phonèmes au niveau de l'attaque syllabique a été étudié en utilisant trois tâches de sensibilité phonologique ainsi qu'une tâche d'orthographe. Les sujets de l'étude étaient des enfants tchèques et canadiens anglais de la maternelle et de la première année. Ces deux langues ont été utilisées parce que les attaques syllabiques complexes sont plus fréquentes et plus variées en tchèque qu'en anglais. Donc, il a été postulé que si l'input linguistique affecte la sensibilité phonologique chez l'enfant, les enfants tchèques devraient démontrer une habileté plus développée que les enfants anglophones dans les tâches de sesibilité phonologique et d'orthographe. On s'attendait à ce que cette différence soit évidente parmi les enfants non-lecteurs de la maternelle si l'input linguistique a une influence plus importante sur la sensibilitié phonologique que les habilités à la lecture et l'écriture ou les habiletés cognitives générales.

Les résultats ont démontré que les enfants tchèques possèdent de plus hauts niveaux de sensibilité phonologique que leurs pairs canadien anglais. Les enfants tchèques ont réussi mieux dans deux des trois tâches phonologiques et dans la tâche d'orthographe. La performance des deux groupes était semblable dans la troisième tâche. Les enfants anglophones ont éprouvé plus de difficulté à manipuler les premiers phonèmes du mot quant l'attaque se composait d'un groupe de consonnes, mais les tchèques et les anglophones étaient aussi bien capable de manipuler les attaques à une seule consonne. On a observé des différences entre les groupes de maternelles et un écart très important entre

les groupes de première année. De plus, la tâche d'orthographe a révélé que non seulement les enfants tchèques représentaient mieux les attaques complexes, mais que ces enfants étaient, en général, à un niveau plus avancé du développement des habiletés en orthographe.

L'habileté supérieure des enfants tchèques de maternelle (non-lecteurs) à manipuler les attaques syllabiques complexes suggère que l'input linguistique oral joue un rôle important dans le développement de la sensibilité phonologique et cet effet semble être indépendant de l'effet des connaissances de la lecture et de l'écriture. Les résultats des enfants en première année montrent que les enfants tchèques ont une avance d'au moins deux ans sur leurs pairs anglophones en ce qui concerne la manipulation des attaques complexes. Cet avantage paraît aussi dans l'orthographe, ce qui suggère que l'input linguistique a un effet positif sur l'acquisition de l'écriture ainsi que sur la sensibilté phonologique.

Acknowledgements

To Dr. Maggie Bruck, who expressed an interest in supervising my work just when it seemed that no one in the country shared my phonological awareness bent, I extend a great big thank-you. Dr. Bruck has not only been a first-class teacher on the fine art of research but also frequently guided me in my studies. (Dr. Bruck also tolerated the "dynamic" state of my office and for that, I am truly thankful.)

I wish to thank Dr. Michael Hoover, my adviser, for his statistical know-how, his support, and his listening abilities.

A thank-you, also, to Dr. Glen Piggott for his interest in the study and for his expert advice on questions of phonology.

On the "cross" end of this cross-linguistic study, I must thank Dr. Josef Hendrich who, on my behalf, made all the arrangements for the data collection in Prague at a time when his country was in turmoil.

I further thank Dr. Přemysl Janota who entertained my weekly visits to the Charles University and offered on-the-spot lessons in Czech phonetics.

A big thanks also to my friends and invaluable resource persons, Irena Kuhnová and Jiřina Sládková, for all the library searches, expensive photocopies and documents sent.

Finally, a thank-you to Mr. Art Douglas, Mr. Miloš Kronus, all the principals, teachers and children who co-operated in the project.

Table of contents

List of tables

List of figures

Chapter I: Literature Review

Introduction

Over the past twenty years the study of metalinguistic awareness in children has received much attention. Metalinguistic awareness refers to the ability to reflect upon the nature and functions of language, that is, the ability to attend to the form of language rather than its content. This field of study includes syntactic awareness (Bialystok, 1988; Gleitman, Gleitman, & Shipley, 1972), word awareness (Bowey & Tunmer, 1984; Ehri, 1979), and phonological awareness (Bradley & Bryant, 1983; Bruck & Treiman, 1990; Content, Kolinsky, Morais, & Bertelson, 1986; Fox & Routh, 1975, 1984; Liberman, Shankweiler, Fischer and Carter, 1974; Mann, 1984; Stanovich, 1986, 1990; Treiman & Baron, 1981).

The relevance of metalinguistic awareness and especially of phonological awareness is twofold: firstly it advances the knowledge of child language development, secondly it is intricately linked with the acquisition of literacy. Hence, the delineation of the scope of metalinguistic awareness and of the factors affecting metalinguistic awareness is extremely important. The present study focuses on phonological awareness. It examines the effect of oral-language input on certain phonological awareness skills by comparing two groups of children whose native languages differ in terms of syllabic structure and in the frequency of occurrence of these structures.

Studies on Phonological Awareness

Phonological awareness is commonly defined as the ability to explicitly manipulate sublexical units. It is measured by a wide variety of tasks such as recognizing that words rhyme or begin with the same sounds, counting the number of syllables or phonemes of words, deleting the first or last sounds of syllables of words, blending units to produce words, or isolating the first segments of words.

Currently, it is well established that phonological awareness is not a unitary ability but one which involves several linguistic levels. Initially, however, it was seen as one skill and the primary aim of researchers was to discover its age of onset. There were varying interpretations as to what types of abilities demonstrated phonological awareness and this led to seemingly conflicting results.

One of the first studies was carried out by Bruce (1964). He tested children's awareness of phonemes using a deletion task. Five-, six-, and seven-year olds were required to delete an initial, medial, or final sound in 30 orally presented familiar words and to say what new word would be formed (e.g. 'Hill' → 'ill', 'carD' → 'car', 'monKey' → 'money', 'neSt' → 'net'). Children below the mental age of seven were completely unable to perform the task. Seven-year-olds only averaged 29% correct answers and they had greatest difficulty deleting the medial segments. Bruce concluded that children must attain a level of basic mental ability before they can manipulate speech sounds.

A second early study by Fox and Routh (1975) measured the ability of children, three to seven years old, to segment sentences into words, words into syllables, and syllables into phonemes by having them say "just a little bit" of each. They found that virtually all children could isolate words and syllables and some four-year olds could even segment syllables into phonemes. They argued that, given the correct prompts, even very young children showed awareness of phonemes.

Liberman, Shankweiler, Fischer and Carter (1974) designed a different type of task. They required prekindergarteners, kindergarteners and first graders to identify the number of phonemic segments in syllables, or the number of syllables in words. Each item was presented orally and the children tapped out the number of segments with a wooden dowel. The prekindergarteners were unable to do the phoneme counting task but they achieved a mean of 46% correct responses on the syllable counting. In kindergarten, the mean for phoneme counting was 17% and 48% for syllables. The first grade children showed very significant gains with a mean of 70% on phoneme counting and 90% on syllable counting. This finding suggests that whereas awareness of syllables emerges very early in children, phonemic awareness is virtually nonexistent in children under six. However, phonemic awareness increases dramatically around the time children are in grade one.

The Liberman et al. (1974) study provided the first evidence that syllables and phonemes may hold a separate linguistic status in children's representations of speech and that the syllabic level of representation may be more accessible to preschoolers than the phonemic level (also Fox & Routh, 1980; Mann, 1984; Treiman & Baron, 1981). Research on speech perception provides an explanation as to why this discrepancy may exist. Every syllable has a nucleus (usually a vowel) which is the most salient and durable segment in the syllable. The other segments of the syllable are folded into the nucleus such that the information about successive segments is transmitted more or less simultaneously on the same parts of the sound wave. The nucleus creates a discernible peak of acoustic energy. On the other hand, there is no acoustic criterion by which the phonetic segments of a given word are dependably marked: the correspondence between each segment in the syllable and the acoustic signal is not one-to-one (Liberman, Shankweiler, Liberman, Fowler, & Fischer, 1977; Studdert-Kennedy, 1975).

Although it is well documented that syllable awareness precedes phoneme awareness (Cossu, Shankweiler, Liberman, & Tola, 1988; Mann, 1984; Rosner, 1971), developmental psycholinguists have recently maintained that the progression from syllable to phoneme may not be direct. Phonemic awareness seems to be preceded by an intermediate level of the onset and rime. The onset is the consonant or cluster of consonants that precedes the vowel. The vowel and any ensuing consonants constitute the rime. For example, the word 'clasp' is composed of the onset /cl/ and the rime /asp/. The rime may be further analysed into a head (the vowel) and the coda (syllable-final consonant or consonants).

The independent status of onset and rime units has been proposed by several linguists (Fudge, 1969; Halle & Vergnaud, 1980; MacKay, 1970). Their existence as cohesive units in speech *production* is suggested by speech errors (Fromkin, 1971; MacKay, 1970;). When spoonerisms occur in speech, onsets may be interchanged with onsets (e.g. <u>sk</u>ip on <u>st</u>age → <u>st</u>ip on <u>sk</u>age; <u>d</u>amage <u>cl</u>aim → <u>cl</u>amage <u>d</u>ame) but only very rarely are parts of onsets transposed (e.g. <u>br</u>ake <u>fl</u>uid → <u>bl</u>ake <u>fr</u>uid). It has also been demonstrated that onsets and rimes function as *perceptual* units in adults (Cutler, Butterfield, & Williams, 1987; Treiman, Salasoo, Slowiaczek and Pisoni, 1982). In phoneme monitoring tasks, the detection of words with cluster onsets is more rapid when the presented targets contain the whole onset than when the targets only contain the first phoneme of the cluster. The same matching effect occurs for words with singleton onsets. For example, the /b/ in /bead/ is detected faster when the target is /b/ than when it is /bl/ but the reverse is true for the word /bleed/.

The first experiment in which children were asked to delete onsets from rimes was reported by Calfee (1977). (It should be noted that he did not define his task as such and no allusion was made to onsets as isolable linguistic units.) Calfee trained five- and six-year-old children to strip onsets from rimes and to say what word is left. For example children were told: "When I say 'spies' (or 'pies') you should say 'eyes' ". It seemed that children easily learned this task as they responded correctly 80% of the time on a transfer task. This is rather surprising in view of Bruce's (1964) earlier findings that children experience great difficulty with phoneme deletion. Quite possibly, Calfee's subjects achieved such high levels of performance because they learned to strip onset units rather than individual phonemes.

Whether onsets and rimes are psychological units for children has mainly been addressed by Rebecca Treiman (1985a; Bruck & Treiman,1990; Treiman & Zukowski, in press). In an initial investigation, Treiman (1985a) examined seven-, eight-, and nine-year old children's ability to manipulate onsets and rimes in a phoneme substitution task. Consonant-consonant-vowel (CCV) and consonant-vowel-consonant (CVC) nonwords were presented in two conditions. Condition A required children to substitute the first two phonemes with two consonants /sl/ in the case of CCV words (e.g. /<u>fr</u>u/ → /<u>sl</u>u/) and with a consonant-vowel sequence /lʌ/ in the CVC words (e.g. /<u>mo</u>n/→ /<u>lʌ</u>n/). In condition B, the last two phonemes were replaced by /li/ on CCVs (e.g. /f<u>ru</u>/ → /f<u>li</u>/) and /ʌl/ on CVCs (e.g. /m<u>on</u>/ → /m<u>ʌl</u>/). Thus in each condition, substitutions of whole onset and rime units were contrasted with substitutions of segments across the onset-rime boundary. Treiman found that children replaced rimes with a fixed syllable more readily than they replaced onsets. However, the most difficult task was to substitute phonemes for sequences of segments that crossed the onset-rime boundary. She further investigated whether children treat complex onsets (those composed of two consonants) as integral units in a phoneme recognition task. Children made more errors when the target sounds were embedded in clusters than when they were singleton onsets (e.g. recognizing /s/ in /san/ was easier than recognizing /s/ in /sna/) .

On various versions of the same-different judgement task, (e.g. "Do 'ball' and 'bag' have the same sound at the beginning?") Treiman and Zukowski (1990) examined whether there is a developmental progression in children's awareness of syllables, onset-rimes and phonemes. They asked preschool, kindergarten and first grade children to judge whether two words shared sounds in a syllable (e.g. '<u>ha</u>mmer' - '<u>ha</u>mmock'; 'pa<u>role</u>' - 'en<u>roll</u>'), onset-rime(e.g.'<u>br</u>oom' - '<u>br</u>and'; 'cr<u>unch</u>' - 'b<u>unch</u>'), and phoneme condition (e.g. 'blue'-'brave'; 'love'-'have'). Indeed, children found the tasks easier as they got older, and, performance was best on syllables, poorer on onsets and rimes and worst on phonemes. In four subsequent experiments, using the same task, children's awareness of onsets and rimes was examined more closely. The results showed that rime judgements are easier than onset judgements and that children are more apt to judge that two words begin with the same sound when whole onsets are shared (e.g. 'glass'-'glove'; 'born'-'bump') than when only the first phoneme of the onsets are shared (e.g. 'bran'-'blue').

Bruck and Treiman (1990) took these findings a step further. They gave first and second grade children a variety of experimental tasks which manipulated singleton and cluster onsets. On every task, children had greater difficulty manipulating parts of onsets (i.e. phonemes) than whole onsets indicating that onsets and rimes are psychologically real units to children. Rimes proved to be the more salient of the two, and the constituent phonemes of complex onsets remained obscure even for children in third grade.

In view of these findings it is not surprising that Bruce's (1964) subjects found the deletion task and the deletion of medial segments in particular so difficult. In his task the to-be-deleted sounds had the status of phonemes rather than onsets and rimes; furthermore, they were frequently the least salient segments of the unit.

One group of researchers has approached the phonological awareness question from another perspective, arriving at conclusions which connect well with the onset-rime results just reviewed. Bradley and Bryant (1978, 1983; Bryant & Bradley, 1985; Bradley, 1988; MacLean, Bryant, & Bradley, 1987) view children's ability to appreciate rhyme as the most rudimentary form of phonological awareness. In a longitudinal study, MacLean, Bryant, and Bradley (1987) tested three- and four-year-old children's knowledge of nursery rhymes. Over the next two years the children's sensitivity to rhyme was measured with a task that required children to identify which of three or four words did not rhyme with the others. They found strong correlations between nursery rhyme knowledge at three years and rhyme recognition ability at five when IQ and parental education were partialled out. Thus, children's awareness of speech sounds may be rooted in their experience with nursery rhymes and word games. This is supported by findings that rime units are easier to manipulate than onsets because, of course, words that share rimes rhyme.

In summary, phonological awareness can no longer be treated as a unitary ability. It develops hierarchically and is constrained by structural linguistic factors. It is demonstrated at different ages by different abilities. Children as young as three years show sensitivity to rhyme (Chukovsky, 1963; Dowker, 1989; MacLean et al., 1987). Four- and five-year olds show adequate awareness of syllables, and emergent awareness of onsets and rimes (Bruck and Treiman, 1990; Liberman et al. 1974; Treiman, 1985a, Treiman & Zukowski, in press). Six- and seven-year olds begin to recognize phonemic units (Bruce, 1964; Liberman et al., 1974; Liberman, Shankweiler, Liberman, Fowler, & Fischer, 1977; Perfetti, Beck, Bell, & Hughes, 1987; Tunmer & Nesdale, 1985).

An unresolved research issue in the field concerns the factors underlying or influencing the development of phonological awareness. Three factors are discussed in the literature: written language input (literacy), general cognitive abilities, and oral language input. This last factor has received the least amount of attention to date.

Written Language Input and Phonological Awareness

The factor that has received the most attention is written language input or literacy. In fact, it is because of the well established finding that phonological awareness and reading skill are highly correlated that so much research has been devoted to phonological awareness (Ball & Blanchman, 1991; Baron & Treiman, 1981; Bradley & Bryant, 1983; Bryant & Bradley, 1985; Bruck & Treiman, 1990; Bryant, MacLean, Bradley, & Crossland, 1990; Calfee, Lindamood, & Lindamood, 1973; Fox & Routh, 1976; Freebody, & Byrne, 1988; Liberman, Shankweiler, Liberman, Fowler, & Fischer, 1977;

Lundberg, Frost, & Petersen, 1988; Perfetti & Hogaboam, 1975; Perfetti, Beck, Bell, & Hughes, 1987; Stanovich, Cunningham, & Cramer, 1984; Torneus, 1984; Treiman & Baron, 1981; Treiman & Zukowski, in press; Tunmer & Nesdale, 1985; Wagner, 1988; Wagner & Torgesen, 1988; Williams, 1980; Yopp, 1988).

For example, a large-scale study by Calfee, Lindamood, and Lindamood (1973) evaluated the relationship between phonemic segmentation ability and reading and spelling achievement in children from kindergarten through grade twelve. The phonemic awareness measure was one in which subjects are required to represent and manipulate speech sounds with colored blocks. Three subtests of increasing difficulty were administered as well as standardized tests of reading and spelling achievement (WRAT). Overall, scores on the phonemic awareness test explained over 40% of the variance in WRAT reading and spelling scores. Similar findings are reported by Fox and Routh (1978) who tested good, average and poor first grade readers on the phonemic segmentation task used in their earlier study (Fox & Routh, 1975). In comparison to good and average readers, the poor readers showed a striking deficit in phonemic segmentation.

Baron and Treiman (1980) looked more closely at what specific components of reading skill were related to phonological awareness. They identified children in grades one to four as either analytic or whole-word readers by their ability to read nonwords, regular, and exception words. All children were given a segmental analysis task requiring same-different judgements about pairs of word-initial and word-final phonemes. Segmental analysis correlated more with nonword reading (a measure of analytic reading) than with exception word reading (a measure of reading by visual access). This finding is important because nonword reading is recognized as an index of children's ability to apply spelling-sound knowledge in reading, which in turn is one of the basic components in the acquisition of skilled word recognition (Backman, Bruck, Hébert, & Seidenberg, 1984; Biemiller, 1977-1978; Mc Cormick & Samuels, 1979; Pace & Golinkoff, 1976; Perfetti &

Hogaboam, 1975). Baron and Treiman (1980) demonstrated how phonological awareness is tied to this basic skill.

Spelling and Phonological Awareness

The bulk of the research in this area focuses on the relationship between phonological awareness and reading. However, the few studies that have included spelling tests among their outcome measures of literacy (Bryant & Bradley, 1985; Bryant, MacLean, Bradley & Crossland, 1990; Calfee, Lindamood, & Lindamood, 1973; Lundberg, Frost, & Petersen, 1988; Torneus, 1984) indicate that phonological awareness is at least as strongly related to reading as it is to spelling. In fact, phonological awareness has been found to bear a larger influence on spelling ability than on reading ability in elementary school children (Torneus, 1984) and in older high school students (Perin, 1983). This effect is stronger in spelling because, especially in the formative years, spelling requires extensive reliance on phonological information in the conversion of sound representations to graphemic ones. This being the case, an indication of children's phonological awareness as well as their phonological representations should be reflected in their spellings. Indeed, the study of children's spellings, produced under experimental as well as unconstrained conditions, has gained popularity in recent years (Ehri, 1984; Ehri & Wilce, 1987; Marcel, 1980; Read, 1975; Treiman, in press).

A common finding in young children's invented spellings is that they reflect phonetic (surface) rather than phonemic or morphophonemic (deep) representations of words (Ehri, 1984; Read, 1975; Treiman, 1985b). For example, spellings like chrie ("try"), chrac ("truck") jragin ("dragon") and jrad ("drowned") indicate that children are treating the /t/ and /d/ segments before /r/ as allophones of the acoustically similar affricates (/č/ and /ǰ/), at least in their written representations. Read (1975) reports that 30% of kindergarten children identify words beginning with /ch/ and /tr/ as well as /ǰ/ and /dr/ as having the same initial sounds in oral and spelling judgements . Similar phonetic tendencies appear in the over-representation of the alveolar flap with the letter d (e.g. wodr for "water") which in written English may be spelled with a t or d but is always voiced in articulation and hence more closely resembles /d/ (Ehri, 1984). Young children also reduce word-initial and word-final consonant clusters in spelling, generally by omitting the consonant closest to the syllabic nucleus (Marcel, 1980; Treiman, in press). These observations shed light on children's developing phonological representations. However, actually manipulating spelling tasks in tandem with phonological awareness is necessary in order to uncover the specific cross-modal links. Only a few studies have included such designs.

Along with adult illiterates and aphasic patients, Marcel (1980) compared eight- and nine- year-old children on phonological awareness, speech perception, speech production and spelling tests. The only test which showed some relation to spelling in terms of error types was phoneme segmentation. Cluster reduction was the common element in the two tasks. In the same way that subjects tended to underestimate the number of segments in orally presented stimuli containing consonant clusters, they frequently failed to represent both consonants in a cluster in their spellings.

Treiman (1985b) measured children's ability to manipulate words beginning with /č/ and/tr/, /ǰ/ and /dr/ in a phoneme recognition task, and related this to their spellings. Children who used affricate spellings to spell /tr/ and /dr/ tended to state that these stimuli did not begin with /t/ and /d/. Similarly, children who used stop consonants in their spellings of the /č/ and /ǰ/ sounds tended to claim that these started with /t/ and /d/.

Bruck and Treiman (1990) also went beyond establishing the link between general measures of phonological awareness and general measures of literacy. As part of the study discussed earlier, they explored the relationships between awareness of specific linguistic units (i.e. onsets) across modalities. The authors examined whether children's spelling patterns would reflect their specific difficulties on various oral phonological awareness tasks. They hypothesized that if children treat cluster onsets as units, this should be reflected by performance on both oral and spelling tasks. The results were as expected. On the spelling task, children omitted consonants more frequently in CCV words than in CVC words, and, in CCV words, the second consonant was omitted more frequently than the first. Similarly, on the auditory recognition task children found the second consonant in a cluster onset more difficult than the first consonant. The correlation between second consonant omissions in spelling and second consonant recognition in auditory recognition was significant. Experiments such as this establish a very specific connection between oral phonological awareness abilities and their role in literacy, namely in spelling.

Relationships Between Phonological Awareness and Literacy

Although the relationship between phonological awareness and reading and spelling is well established, its causal underpinnings are not so clear. On the basis of the above-mentioned studies, it is difficult to determine how phonological awareness is implicated in the reading process because most of the subjects were already literate or had some experience with print. It may be that good readers quickly grasp the idea that letters represent speech sounds and develop a sensitivity to them. But the reverse may also be true: children who possess high levels of phonological awareness prior to reading instruction may apply that knowledge to decoding words more readily than children with low phonological awareness.

There are, in fact, two strong positions regarding the issue of causality. The first claims that alphabetic literacy is the factor which critically influences phonological awareness, particularly at the phonemic level (Ehri, 1979, 1984; Ehri & Wilce, 1980; Morais, Alegria, & Content, 1987; Morais, Bertelson, Cary, & Alegria, 1986; Read, Zhang, Nie, & Ding, 1986). The strongest evidence for this claim is that children typically develop phonemic awareness around the age of six, in effect, when they begin learning to read. The second view is that phonological awareness including phonemic awareness are skills which develop throughout early childhood and are the very same ones that enable reading. That is, phonological awareness is a prerequisite to the acquisition of literacy (Bryant & Bradley, 1985; Bryant. MacLean, Bradley, & Crossland, 1990; Goswami, 1986, 1988; Liberman et al., 1977). A more conciliatory position is now emerging, which states that phonological awareness does influence learning to read, but learning to read further raises phonological awareness (Perfetti, Beck, Bell, & Hughes, 1987; Wagner, 1988; Wagner & Torgesen, 1987).

A long-time proponent of the theory that early reading experiences advance children's awareness of phonemes is Linnea Ehri (1979, 1984; Ehri & Wilce, 1987; Hohn & Ehri, 1983). She posits that although awareness of syllables and rimes may facilitate the initial reading process, it is mainly through experience with print that children learn about phonemes. Prior to learning about letters of the alphabet and their sounds, the child has no reliable basis for mapping phonemes onto an internal representation because phonemes are neither stable nor fully discrete elements in speech. The preliterate child already has a phonological, semantic and syntactic identity for every word in memory but no visual representation exists. When faced with print, the child's most reliable option is to map the letters to the sound representations in order to access meaning. As learning progresses, visual (orthographic) representations are added to the existing ones and a new amalgamated representation develops which can eventually be accessed without reliance on the phonological code. Thus phonemes and letters become part of the same lexical representation and the latter become the units onto which individual phonemes are mapped.

In support of this theory, Hohn and Ehri (1983) showed that prereaders unable to perform phonemic segmentation developed this ability after learning to segment nonwords using letter tokens or blank tokens. Both methods led to successful segmentation of transfer words. The "letter" group, however, performed significantly better than the "blank token" group on segmenting trained sounds. The authors concluded that the advantage of the letter group in segmenting trained sounds reflected these children's use of letters as mental symbol systems for representing specific phonemes. Similar results were obtained by Bradley and Bryant (1983) with poor readers.

Even though Ehri acknowledges the importance of early phonological skills as facilitators to reading acquisition, she believes that phonemic awareness develops in a true sense only as a result of reading. Less compromising is the view of Morais, Cary, Alegria, and Bertelson (1979). They argue that early manifestations of phonological awareness such as rhyme and alliteration are separate, global linguistic skills unrelated to reading and that phonemic awareness is the product of literacy. It is the experience with print and letter-sound correspondences that alerts readers to phonemic units. To provide evidence for this position, they compared illiterate Portuguese adults to a group that had recently learned to read in literacy courses. All subjects were given a phoneme addition (e.g. add /p/ to 'alhaco' → 'palhaco') and a phoneme deletion (e.g. remove the /p/ from 'purso' → 'urso') task on words and nonwords. The literate adults performed significantly better than the illiterate group. The illiterates were able to manipulate phonemes in some real words but were virtually unable to do the same with nonwords.

The study was criticised (Bryant & Bradley, 1985; Bryant & Goswami, 1990) on the grounds that there may have been effects of self-selection in the literate group, that the difficulty subjects experienced with nonwords may have been due to difficulty in dealing with nonsense words per se rather than with phonemes, and, that phonemic awareness was not contrasted with awareness of larger linguistic and non-linguistic units.

In response to the criticism, Morais, Bertelson, Cary, & Alegria (1986) replicated and extended the original study. Again, illiterate and recently literate adults were tested on phonemic awareness in nonwords, but also on a variety of tasks involving the manipulation of syllables, rimes, and a music task in which the experimenter played a four-note tune and the subjects had to sing the last three notes. The only task on which literates and illiterates fared equally was the music task; both groups found it difficult. On the remaining tasks, illiterates consistently scored lower than the literate group although all tasks involving the manipulation of phonemes were by far the most difficult. Unlike the conclusion of the 1979 study, these results imply that phonological awareness at the level of phonemes as well as syllables and rimes is lower in non-reading adults and that literacy drives the development of all levels of phonological awareness.

Another way to examine the effect of literacy on phonological awareness is to study the ability in readers of nonalphabetic scripts. If indeed phonological, and especially phonemic, awareness is acquired through orthographies which use the phoneme as the unit of graphemic representation, Chinese and Japanese readers should have poor phonemic awareness. Read, Zhang, Nie, and Ding (1986), compared Chinese adults who had received traditional logographic reading instruction to a group that had been taught to read *pinyin* (an alphabetic writing system) on phoneme addition and deletion tasks much like those in the Morais et al. (1979) experiment. The pinyin readers performed significantly better on both tasks. Read et al. concluded that phoneme segmentation skill does not develop in speakers of nonalphabetic languages.

Mann (1986) examined the phonological awareness of Japanese children and compared their abilities to those of same-aged American children. Japanese children learn two nonalphabetic scripts: kanji which are Chinese logograms and kana in which each symbol represents a syllable. Children do not learn about phonemes. Mann gave six-year olds phoneme and syllable counting tasks as well as phoneme and syllable deletion tasks. The Japanese group found both phoneme tasks much more difficult than syllable manipulation. They performed more poorly than their American peers on the phoneme tasks but the groups did not differ on syllable counting or syllable deletion. The tasks were also administered to nine- and ten-year-old Japanese children who were quite able to perform both syllable and phoneme manipulations. Mann suggests that this awareness develops indirectly as children learn the kana. A strategy often used by teachers is to point out that different kana share initial and final sounds with the one being taught. Thus children become attuned to phonemes although not in a formal manner.

Although these studies demonstrate that phonological awareness is considerably influenced by alphabetic literacy, other evidence suggests that in fact phonological awareness is the causal factor of individual differences in reading. Liberman et al. (1974) hypothesized that phoneme awareness is crucial to the acquisition of reading because although phonemes are not clearly demarcated in the acoustic output of speech, they are represented to a certain degree of accuracy in alphabetic scripts. Therefore, the mastery of reading in alphabetic systems requires an a priori awareness of the speech sounds that graphemic symbols represent. In a follow-up of their 1974 study (reported in Liberman, Shankweiler, Liberman, Fowler, & Fischer, 1977), Liberman et al. tested the same children's reading achievement at the beginning of their second school year. The children who were reading within the lowest third of their class were those who had failed the phoneme segmentation task the previous year. On the other hand, none of the readers in the top third of the class had failed to segment phonemes. Unfortunately, in the initial study, reading ability had not been evaluated. Therefore, the possibility remains that the children who were better at phoneme counting were advantaged by experience with print to begin with.

In a more recent study, Mann and Liberman (1984) controlled for IQ as well as for reading ability and obtained a significant correlation of .40 between kindergarten syllable segmentation and reading one year later. A much stronger correlation ($r = .75$) was obtained by Mann (1984) between phoneme reversal ability in kindergarten and reading in grade one. In that study, the correlation between syllable reversal and reading was not significant.

Share, Jorm, MacLean, and Matthews (1984) investigated the effect of social, behavioural, motor, cognitive, literacy, verbal, and phonological awareness factors on reading achievement in a two year study with Australian youngsters. Five hundred and forty-three children were tested on all measures at the beginning of their kindergarten year and were retested on reading at the end of kindergarten (in Australia formal reading instruction begins in kindergarten) and grade one. In a stepwise regression analysis, phoneme segmentation explained the greatest amount of variance in reading at the end of the first grade.

An impressive longitudinal study was carried out by Bradley and Bryant (1983). At the outset, 403 four- and five-year olds were administered a phonological awareness measure. A standardized reading test was used to screen out readers. The phonological awareness task was a sound categorization task in which children are presented with two words that share an initial, medial, or final phoneme and a third word that does not share any phonemes. The children must identify the "odd word out". Significant correlations were obtained between children's initial scores on sound categorization and reading and spelling three years later, even after initial and final IQ and memory scores were controlled. Performance on sound categorization was not related to math achievement suggesting a specific causal connection between phonological awareness and literacy skills.

Stanovich, Cunningham and Cramer (1984) evaluated the predictive value of ten phonological awareness tasks that had been used in various experiments and compared these to the predictive power of standardized reading and IQ tests. They found that seven of the tasks given to kindergarteners explained approximately 58% of the variance in reading ability one year later. When tasks were clustered, they were actually equal or stronger predictors than the traditional standardized tests. The three tasks that failed to predict reading achievement were rhyming tasks of the sort used by Bradley and Bryant. This discrepancy was caused by ceiling effects. Apparently by kindergarten the ability to detect rhyme is no longer useful as a measure of phonological awareness.

Bryant, MacLean, Bradley and Crossland (1990) examined the impact of the earliest phonological abilities on more difficult skills as well as on reading and spelling. Four-and-a-half-year-old children were monitored for two years on phonological awareness and progress in reading and writing. The question addressed was whether rhyme recognition and alliteration at four years predict deletion and phoneme tapping ability at five which in turn predict reading and spelling achievement. Strong correlations were found between rhyme and alliteration and the phoneme detection (segmentation and deletion) measures after parental education, verbal IQ, general IQ and age were controlled. Furthermore, rhyme and alliteration scores at age four explained between 65% and 71% of the variance in the reading and spelling measures when phoneme tapping and phoneme deletion scores in addition to the above variables were controlled. Thus the earliest phonological awareness skills directly affected the development of phoneme detection skills prior to reading instruction but they also predicted reading and spelling achievement independently of these higher-level skills. Unfortunately phonological awareness measures were not administered at the end of the study which precludes any conclusion about the potential effect of reading on phonemic awareness.

Perhaps the most compelling evidence for the causal influence of phonological awareness on reading and spelling comes from training studies. It has been shown that training programmes which focus on phonological awareness have long term benefits in terms of reading skills for both prereaders (Ball & Blachman, 1991; Elkonin, 1973; Fox & Routh, 1976,1984; Lundberg, Frost, & Petersen, 1988) and poor readers (Bradley & Bryant, 1983, Williams, 1980).

Ball and Blachman (1991) report that a seven week programme, designed for kindergarteners enabled these children not only to perform phonological awareness tasks but also to grasp the basics of reading and spelling. A programme of longer duration was carried out in Sweden (Lundberg. Frost and Petersen, 1988). Eight months of daily phonological awareness training in kindergarten had positive and lasting effects on children's reading and writing abilities to the end of the second grade.

Studies with poor readers have also shown that specific phonological instruction has very positive effects on poor readers but explicitly linking the sounds to the orthography seems more advantageous for these children. In Bradley and Bryant's (1983) 40-session training, the best results were obtained by a group that was taught rhyme recognition and alliteration *and* were shown the spellings of the words with plastic letters. Williams' (1980) full-year programme was designed for disadvantaged children classified as reading disabled and they too showed gains from explicitly training on phonological and orthographic activities.

Evidence then supports the theory that literacy is an important factor in the development of phonological awareness but also that phonological awareness is a very important determinant of reading and spelling ability. Wagner and Torgesen (1987) point out that in order to elucidate the role of both factors, each should be fully examined as predictor and as outcome variables. That is, some studies fail to control for reading ability at the outset of the experiment while others fail to measure phonological awareness at the end. One example of the former problem was demonstrated by Wagner and Torgesen. They reanalyzed the data of a longitudinal study carried out in Sweden (Lundberg, Olofsson, & Wall, 1980). The original results yielded simple correlations between .13 ($p<.05$) and .55 ($p<.001$) for phonological awareness measures in kindergarten and reading in first and second grades. When Wagner and Torgesen controlled for reading ability in kindergarten, only two of the nine partial correlation coefficients reached significance at the .05 level.

A plausible theory, and one that is gaining increasing support, is one of bidirectional causality between phonological awareness and reading (Perfetti, Beck, Bell & Hughes, 1987; Stanovich, 1986; Wagner, 1988). By this view, children need to master a certain ability of phonological manipulation in order to understand and use an alphabetic writing system. As they learn to read, the script and the skills required in reading further raise children's awareness of and ability to manipulate linguistic units, particularly phonemes.

Perfetti, Beck, Bell and Hughes (1987) argue that different phonological skills affect and are affected by reading. Phoneme synthesis, the ability to combine isolated phonemes into syllables, is a fairly primitive aspect of phonemic knowledge, whereas phonemic analysis tasks, such as segmentation and deletion, are both more difficult and more reflective of a sophisticated linguistic ability. The authors hypothesized that the more primitive measure (synthesis) would be a better predictor of eventual reading ability, whereas reading achievement would better predict analysis scores. First grade children were tested on both synthesis and analysis tasks in the first week of school and on those same measures as well as on word and nonword reading on three subsequent occasions throughout the school year. Synthesis ability prior to reading instruction was the best predictor of word reading ability. As the year progressed, phoneme deletion and phoneme tapping (the analysis tasks) became the stronger predictors explaining 77% of the variance in word reading. However, time-lag correlations revealed that reading ability at time one predicted analysis scores at time two, which in turn predicted reading at time three.

Perfetti et al. concluded:

> The results strongly suggest that there are different components of explicit phonemic knowledge and that these bear different relations to reading progress. Synthesis taps an essential but primitive knowledge of segmentation. Success at reading depends on it. Deletion taps a nonessential but sophisticated segment analysis ability. Learning to read brings about success on this task perhaps because it fosters attention to constituent principles. (p.317)

In agreement with this view, Content (in press) writes that awareness of various units of oral language is an important facilitator in early reading. Unless phonemic awareness is explicitly taught to prereaders, however, it develops through discovery of the alphabetic code and reading experience.

General Cognitive Ability and Phonological Awareness

It is possible that both phonological awareness and reading are affected by an encompassing factor such as general cognitive ability (Tunmer, Herriman, & Nesdale, 1988). The view that metalinguistic awareness is contingent upon cognitive development is advanced by Tunmer, Pratt, and Herriman (1984). They posit that metalinguistic abilities are a developmentally distinct kind of linguistic functioning that emerge during middle childhood along with concrete operational thought. Tunmer and Herriman (1984) argue that:

> The essential feature of both metalinguistic awareness and concrete operational thought is the ability to *control* the course of one's own thought, which suggests that both may be the reflection of a more general change in underlying cognitive capabilities, the development of "metacognition". (p.30)

Their hypothesis implies that non-metalinguistic tasks involving decentration and control processing should correlate with metalinguistic abilities. In a study with first grade children, Tunmer & Fletcher (1981) found significant correlations between two measures of control processing (a figure matching task and a phoneme tapping task) when IQ was held constant. They concluded that the two tests shared a common underlying feature in cognitive processing, namely cognitive control. Bialystok (1988, 1990) proposes that performance on metalinguistic tasks (including reading) is contingent upon two processes which are derivatives of more general cognitive processes: analysis of linguistic knowledge and control of attentional processing. She has found that these two components, as measured by grammaticality judgements and form-meaning judgements, are related to cognitive measures such as block design and digit span (performance subtests of the WISC-R) and to reading comprehension and reading proficiency.

More recently Tunmer, Herriman, & Nesdale (1988) examined the role of general cognitive ability, metalinguistic ability (measured by phonological awareness), verbal intelligence and reading in a longitudinal study. A test battery was administered to nonreaders at the beginning of grade one and again at the end of the first and second school year. They expected that if operativity affects metalinguistic awareness, which in turn affects reading acquisition, operativity scores alone should predict reading ability. On the other hand, if metalinguistic awareness is a distinct ability, it should predict reading ability independently. Finally if metalinguistic ability and operativity emerge as a result of learning to read, the correlations between initial measures of the metalinguistic awareness and operativity and reading ability at the end of first and second grade should not be significant. Operativity explained a significant proportion of variance in all metalinguistic measures but verbal intelligence did not. Both phonological awareness and operativity were significantly correlated with pseudoword decoding. Evidence for the implication of cognitive functioning in phonological abilities came from a group of children who performed poorly on phonemic segmentation but well on the operativity tasks at the beginning of grade one and whose phonological scores improved significantly by the end of the year. Low achievers on both phonological awareness and operativity at the outset continued to do poorly on all measures. Path analyses revealed independent effects of phonological awareness on pseudoword decoding and a significant but indirect effect of operativity on pseudoword decoding. However, operativity had a stronger indirect effect on reading comprehension than did any other variable. Tunmer, Herriman and Nesdale (1988) concluded that some minimal level of phonological awareness is necessary in the early stages of learning to read; however, cognitive abilities are also causally related to word recognition and especially to reading comprehension.

Tornéus (1984) also found phonological and cognitive ab[illegible] have separate and direct effects on reading proficiency. She suggests that this is because reading (as opposed to spelling) involves the integration of higher level skills which tap cognitive (nonlinguistic) processes.

By extension, two findings suggest that cognitive development does not critically influence the development of phonological awareness. First, longitudinal studies show phonological awareness to predict reading ability long before operativity develops (MacLean et al., 1987; Share et al., 1984). It has been proposed (Donaldson, 1978) that control operations in fact develop as a function of formal schooling and more specifically of learning to read. It is the process of reading acquisition that facilitates the transition from embedded thought to disembedded thought. In turn, Tunmer et al. (1984) maintain that in order to make that transition children need a certain level of metalinguistic ability (i.e. cognitive control), otherwise they would not be able to reflect upon language nor discover the correspondences between its oral and written forms. The second indication that phonological awareness is an ability distinct from general cognitive processes is the frequent finding that controlling for IQ does not reduce correlations between phonological awareness and reading achievement (see Stanovich, 1986; Wagner, 1988).

Oral Language Input and Phonological Awareness

It is clear that training programmes and learning phoneme-grapheme correspondences influence phonological awareness as well as literacy skills. Yet, another potentially important factor in developing phonological awareness, that of linguistic structure, has been virtually ignored. Languages differ widely in phonological characteristics and it seems likely that in speakers of different languages, phonological awareness would develop to some degree as a function of the salience of particular phonological structures.

These language-specific differences may be reinforced both by oral language and orthographic input. That is, it may not be simply the acquisition of phoneme-grapheme correspondences, but also the segmental structures most frequently encountered in the written language that play a role in raising phonological awareness. Of course whether an orthography is deep (such as English) or shallow (such as Serbo-Croatian, Czech, Italian) should also make a difference in the impact of orthographic structure as input. Shallow orthographies map sounds to letters in a one-to-one fashion and are said to be phonetic rather than phonological. Deep orthographies do so to a lesser extent. In the case of English the spelling patterns reflect morphology and phonology more than the surface phonetic structure of the spoken language. Because the mappings in shallow orthographies are stable across spelling contexts they may be easier to grasp for beginning readers (Liberman, Liberman, Mattingly, & Shankweiler, 1980). The findings that children's invented spellings tend to be phonetic (Marcel, 1980; Treiman, 1985b) would also fit with this hypothesis; children may learn more about linguistic structure from an orthography that corresponds to their expectations of it (i.e., to their phonological representations of it).

Indirect support for the hypothesis that written word structure in transparent orthographies may affect phonological awareness is provided by cross-cultural studies of word perception. Findings indicate that very opaque orthographies like the Japanese Kanji are conducive to visual access to the lexicon (Morton & Sasanuma, 1984) whereas very transparent orthographies like Serbo-Croatian are conducive to lexical access via the phonological route (Lukatela & Turvey, 1980). Thus, a transparent orthography may make the reader more aware of the phonology of the language.

More direct evidence is supplied by a cross-linguistic study of dyslexic children from Italy and the United States (Lindgren, DeRenzi, & Richman, 1985). These researchers investigated whether the phonetic regularity of an orthography can significantly influence the prevalence and pattern of developmental dyslexia. In both countries, fifth grade children were administered a large battery of tests tapping cognitive, linguistic, perceptual and motor abilities in order to identify dyslexic readers. They included one test of phonological awareness: phoneme blending. Dyslexia was more prevalent in the United States. Auditory-verbal ability was the main factor setting dyslexics and normal readers apart in both countries, although American dyslexics were also weaker in visual-motor skills. Interestingly, the Italian dyslexics were significantly worse than their normally reading peers on phoneme blending. This task did not differentiate normal and poor readers in the United States. However, Italian dyslexics were better at nonword reading than American dyslexics.

The findings suggest that the orthography is an important factor. First, that visual-motor deficits do not interfere with reading in Italian whereas they do in English suggests that visual access routes are more involved in reading English than Italian. Consequently, English-speaking children with visual processing deficits, or phonological processing deficits, or both, are likely to encounter difficulties in reading; ergo the greater prevalence of dyslexia in the United States. Second, the reading problems of Italian dyslexics seem to be rooted in considerable phonological awareness deficits. Note that phoneme blending is a measure of primitive phonological awareness skill and is readily mastered by English first graders (Perfetti et al., 1987). Yet, fifth grade Italian dyslexics are much poorer at this task than normal readers whereas American dyslexics perform on par with their nondisabled peers. This suggests that, unless they have extremely low levels of phonological awareness, Italian children generally find the task of learning to read less problematic than English-speaking children. Furthermore, such low levels of phonological awareness do not prevent Italian dyslexics from reading nonsense words. Lindgren et al. (1985) attribute this advantage to the transparent orthography of Italian.

However, what is known about phonological awareness is predominantly based on data collected from Anglophone children. Surprisingly, with the exception of the studies by Read et al. (1984) and Mann (1986) on the phonological awareness of readers of nonalphabetic languages, only one cross-linguistic study has been carried out to assess specifically the phonological awareness skills of speakers of two different alphabetic languages.

The study of Cossu, Shankweiler, Liberman, & Tola (1988) was the first (and to date the only) attempt to make such a comparison. Italian was contrasted with English because the languages differ in syllable structure, vowel system complexity and level of orthographic transparency. In Italian, syllables are for the most part open (ending with a vowel), in English they are most frequently closed (ending with a consonant or a cluster of consonants). Also, according to Cossu et al., English has a higher frequency of complex onsets and complex rimes than Italian, and, Italian has a five-vowel system as opposed to the 12 or more vowel inventory of English. The pronunciation of vowels in Italian does not change across spelling contexts whereas it frequently does in English. Cossu et al. hypothesized that Italian children may be more advanced in syllable and phoneme awareness as a result of speaking and hearing a more syllabically simple language. Also,2 they investigated whether the transparency of Italian orthography facilitates the acquisition of phonological skills. Finally they investigated whether phonological awareness is related to individual differences in reading ability as it is in English.

In the first experiment, syllable and phoneme tapping tasks were administered to Italian prekindergarten, kindergarten, first and second grade children. Performances were compared to results obtained from American children by Liberman et al. (1974). The second experiment was designed to evaluate the relationship between phonological awareness and reading ability of Italian children who were good, average or poor readers. No cross-linguistic comparison was made in the latter study.

The first experiment revealed several interesting findings. Italian, like American preschoolers found phoneme segmentation much more difficult than syllable segmentation. Thirteen percent of Italian four-year-olds reached a criterion of six consecutive correct responses on phoneme tapping as opposed to 0% in the American sample. This advantage was evident in all age groups and on both the syllable and phoneme tapping tasks. Italian children also showed a large increase in phoneme segmentation ability from kindergarten to grade one, suggesting that in Italian as in English, experience with written language greatly advances phonemic awareness. However, American first graders still found phoneme segmentation quite difficult with 30% of the children failing to reach criterion. Only 3% of Italian children failed to reach criterion, and the mean performance was near ceiling. Another cross-language difference occurred among the Italian first and second graders who found the syllable tapping task more difficult than the phoneme tapping task although they were near ceiling on both.

These results suggest that the same developmental trend on phoneme and syllable tapping exists among American and Italian children up to the first grade. However, by grade one, Italian children are more proficient at phoneme tapping than syllable tapping. This seemingly odd finding actually reflects differences in phonological awareness development, not a language-specific phenomenon. Bruck (personal communication) observed the same trend among older (third grade) Anglophone children. As they reach ceiling on phoneme tapping, children's syllable tapping performance stabilizes at a subceiling level. Nonetheless, Italian children, at all ages, found both tasks easier than American children.

In the second experiment, first and second graders were grouped by reading ability (good, average, poor). All good readers performed near ceiling on both tasks but made fewer errors on phoneme tapping than on syllable tapping. Average readers showed a significant improvement in phoneme tapping from first to second grade (at which point they performed like the good readers) but remained virtually equal on syllable tapping and slightly weaker than good readers. Poor readers improved in syllable tapping across grades such that they made fewer errors than good and average readers by grade two. Their phoneme tapping scores were low and did not improve across grades.

It is well documented that Anglophone poor readers have great difficulty manipulating phonemes (Bradley & Bryant, 1983; Bruck and Treiman, 1990; Fox &

Routh, 1984; Williams, 1980). The same seems to be true of the problems encountered by poor Italian readers. It is impossible to judge by this study whether the magnitude of difficulty encountered by poor readers is the same across languages. However, the study of Lindgren et al. (1985) suggests that Italian poor readers may in fact suffer greater phonological awareness problems than American dyslexics.

Cossu et al. (1988) concluded that the simpler syllabic structure, the simple vowel system, as well as the more transparent orthography, did indeed put Italian children at an advantage in phonological awareness. Already two years before they learn to read, Italian children are better at phoneme and syllable counting than same-aged American children. The facilitative effect of the Italian orthography is suggested by near-ceiling performances on both tasks in grade one. Although American children, too, improve considerably in first grade, they continue to find syllables easier to manipulat~ than phonemes and they lag behind the Italian children on phoneme tapping.

There were, however, several shortcomings in the Cossu et al. (1988) study. First, the American control group was not specifically matched to the Italian group. In fact the data from a previous study (Liberman et al., 1974) were compared to the Italian group in a post-hoc manner. No statistical analyses were carried out to compare the two language groups, only informal comparisons were made. More importantly, the test items were not very comparable. On both tasks, Liberman et al. had used one, two, and three segment stimuli. Because real words were used in both studies, and because Italian has a very small number of monosyllabic words, the Italian items were of two, three, and four segments. Whereas Liberman et al. (1974) used single nonmeaningful phonemes as their one-phoneme stimuli, the same was not done by Cossu et al. (1988). Finally neither study mentions the relative frequency of the stimulus words which could certainly affect between-language differences.

Rationale

This study was designed to test the effects of oral-language input on phonological awareness skills of Czech and English-speaking children. The specific focus was on the awareness of the cluster-onset as a linguistic unit. As is reported in the following section, two linguistic analyses revealed that the Czech language contains a high frequency and variety of comlex syllable onsets, much higher than English. Complex onsets are units of speech with which English-speaking chilren have considerable difficulty even after they have learned to read. Because English has a reltively low frequency and variety of complex onsets, children's difficulties with these units may be due to a lack of exposure to them. Thus the question of input was addressed in this study. It was hypothesized that if input affects phonological awareness, Czech preschool children should already show greater awareness of the segments that compose cluster onsets than English children. This higher level of awareness should be evident in Czech children's spellings of words containing cluster and singleton onsets. If, on the other hand, awareness of complex onsets is affected by general maturational factors, no differences between Czech and English children should be observed. This study is reported in chapters III to V.

However, to the knowledge of the author, no formal comparison of cluster-onsets between the two languages has been carried out. Thus, prior to undertaking the behavioural study, two linguistic analyses were performed in order to document that Czech is indeed richer in clusters than English. The results of both analyses as well as a general description of some phonological characteristics of Czech and English are reported in Chapter II.

Chapter II: Comparative Analysis of Czech and English

The objective of this study was to document the frequencies and types of word-initial consonant clusters in English and in Czech. A secondary analysis was also carried out to compare clusters in word-final positions because one task in the main experiment (Nonword Spelling) involved these as an independent measure. First, however, a comparison of some general characteristics of English and Czech phonology that are relevant to this study are presented.

A General Comparison of English and Czech Speech Sounds

A Czech speaker's typical description of the English language is that it sounds as though Anglophones speak "with marbles in their mouths". Anglophones, on the other hand, often qualify Czech as "tongue-breaking gibberish". These lay descriptions reflect fundamental differences in the use of vowels and consonants in the two languages. The image of "marbles in the mouth" suggests the salience of vocalic sounds in English, whereas "tongue-breaking" articulation reflects the perception of the complex combinations of consonants in Czech. Both are astute observations.

Among the many factors distinguishing the word-structure of Czech and English, two are of immediate interest. The first is at the level of phonemes; the second is at the level of syllables. It is the characteristics of phonemes and of syllables which in fact underlie the differing use of consonant clusters in each language.

In the realm of the phoneme, the very mode of articulation in Czech and English is such that it produces sounds with distinctive qualities. In a comparative study of Czech and British English phonetics, Skaličková (1974) points out that because the two languages have different articulatory bases, the sound elements produce different acoustic outcomes. In English articulation, the tip of the tongue almost never comes in contact with the bottom parts of the oral cavity. Rather it rests freely in the front in a more or less concave, apical position. In Czech, the tip of the tongue is almost always in contact with the bottom of the oral cavity, resulting in a generally dorsal and convex articulation. However, the sound elements also differ in function, use, distribution and their possibilities of sound combinations. Despite these important differences, many phonemes are allophones of sounds common to both languages.

The second distinguishing characteristic of word-structure is the proportion of mono- and multi-syllabic words comprising the lexicon of each language. The frequency of mono- and bi-syllabic words in Czech is approximately equal whereas English has a predominance of mono-syllabic words. For example, in the present study, two adult and two children's 200-word passages of written prose were randomly selected in Czech and in English, and all words were coded for the number of syllables they contained (see Appendix A). In Czech, monosyllabic words represented 35% of all words, bi-syllabic words accounted for 33%, tri-syllabic words were slightly less frequent at 21% and four-syllable words comprised 9% of the total. Five- and six-syllable words represented the remaining two percentage points. The English break-down showed that 74% of the corpus consisted of monosyllabic words, 21% were bi-syllabic words and 4% were tri-syllabic. Four-syllable words were found in the adult texts only and they represented less than one percent of the corpus. No five- or six-syllable words occurred in any of the English texts.

Clearly, monosyllabic words are most common in English representing almost three quarters of the texts in the above analysis. Furthermore, two-syllable words virtually made up the remainder of the corpus. On the other hand, in Czech mono- and bi-syllabic words each constitute approximately one third of the lexicon, and, three- and four-syllable words are much more frequent than in English. One reason for this difference is that Czech is an inflected language in which the affixation of the inflected morpheme is frequently syllable-forming. The implication of these findings will become clearer as the vowel and consonant systems are compared. However, that Czech contains more multisyllabic words provides the first bit of evidence for its more frequent use of onsets, heads and codas (i.e. of vowels and especially consonants).

The vowel systems of Czech and English differ considerably. Despite the lack of consensus regarding exact numbers, English has a complex vowel system. Inventories range from 12 to 19 vowels, and five to eight diphthongs (Dewey, 1923; Ladefogel, 1982; Skaličková, 1974). By comparison, Czech has a fairly simple ten-vowel system in which there are five short and five corresponding long vowels ([a, e, i, o, u, a:, e:, i:, o:, u:]). Three diphthongs exist ([ou], [au], [eu]) of which only one, [ou], is native to the language (Kučera, 1961; Skaličková, 1974). It should not be assumed, however, that English is more vocalic than Czech. Skaličková reports the results of a preliminary analysis in which vowels represented approximately 43% of all speech sounds in Czech as opposed to some 31% in English. This difference is further supported by the syllable data above. Thus although English has a richer vowel system, Czech speakers hear more vowels in the lexical input.

The consonantal systems of the two languages contain approximately the same number of phonemes. English has 24 consonantal phonemes, Czech has 26. Each language has several language-specific phonemes: [θ, ð, w] and possibly [ɫ] in English and [ř, ť, ɲ, ď, χ] in Czech; the remaining consonants are shared by both. However, many of these differ in function, frequency, weighting, and distribution. Consonants which are highly similar in place and mode of articulation are: /p/, /b/, /t/,/d/, /k/, /g/, /č/, /ǰ/, /f/, /v/, /s/, /z/, /š/, /ž/, /j/, /h/, /m/, /n/, /l/.

Skaličková's (1974) extensive study offers a detailed analysis of the entire phonemic inventory in both languages. Although she compares British English to Czech (whereas the present study concerns Canadian English), the differences between English dialects occur in the vowel systems, not in consonants. Her work is used here to describe only those consonants used to make up the stimuli used in the main experiment, which differ considerably in manner of articulation, features, distribution and or frequency.

The phoneme that differs most markedly in Czech and English is [r]. First, the place of articulation is further forward in Czech than in English. Second, in the manner of articulation the Czech [r] is a trill involving a flapping of the tip of the tongue (usually two or three times), whereas the English [r] is not a trill. Third, the English [r] is usually accomplished with a rounding of the lips, in Czech the lips remain in a neutral position. Fourth, the English [r] loses voicing when preceded by voiceless consonants (e.g. 'try', 'cry', 'prove'), but it is always voiced in Czech. Fifth, in distribution, the English [r] can precede only vowels or a syllabic [l]; in Czech it can precede vowels and consonants, and, in its syllabic form it can appear interconsonantally (e.g.[kr̩k], [kr̩b]).

English and Czech have a [l] phoneme which is quite similar in acoustic outcome. However, English also has a variant, [ɫ], that has no analog in Czech. It appears in word-final ([pʊɫ]) and preconsonantal ([bʌɫk]) positions, and, can assume a syllabic role ([seʔɫ]). Unlike English, the Czech [l] can be found word-initially, before consonants ([lha:ř], [lsťivi:]) otherwise it appears in the same positions as in English. Whereas both [l] and [ɫ] lose their sonorance by assimilation in certain positions (e.g. 'please', 'clue'), the Czech [l] is always sonorant.

The phoneme [ŋ] is an independent phoneme in English whereas in Czech it is merely an allophone of [n] used when preceding [k] or [g]. The English [f] is a very frequent native sound but is a foreign element in Czech, figuring in adopted words, onomatopoeia, or as a product of assimilation in particular placements. The consonant [g] is frequent in English. In Czech it is very infrequent as an underlying sound and appears only in exceptional words. However, [g] is the product of assimilation in the combination /kd/ which is the onset of question words ("wh" words in English), thus the cluster [gd] occurs frequently in the speech stream. In English [h] is a non-contrasted phoneme whereas in Czech it is contrasted with the unvoiced velar [χ]. Both [h] and [χ] can be part of a cluster pre- or post-consonantally in word-initial and medial positions (e.g.[hra:t], [zhasla], [χrapťi:], [sχra:ŋka]). The English [h] appears only in pre- and post-vocalic positions, and before [j] as in [hjʊj].

Another distinction concerns the role of the phoneme [j]. In English it is considered a semivowel usually appearing in diphthongs (e.g. [bo:j]). When inflected, as in /boys/, the [j] maintains its semivowel status [bo:jz]. In Czech it clearly behaves as a consonant. Although it seems to have the same function when found in a similar context, for example in the word /boj/ [bɔj], the [j] assumes the role of the syllable onset when inflected /boje/ [bɔ-je].

The aspiration of voiceless stops in prevocalic word-initial and medial positions is a further distinguishing property of Czech and English. Briefly, the English [p], [t], [k] become aspirated in words like [kʰart], [pʰart], [tʰart]; aspiration does not occur in these contexts in Czech nor does it play an important role in other contexts.

Important differences exist in the effects that consonantal combinations produce. Czech and English are diametrically opposed in manner of assimilation. In Czech all consonants may assimilate (take on the voicing value of the adjacent consonant) with the exception of l, r, m, n, ɲ, j. Assimilation can occur at beginnings, middles and ends of words and even across word boundaries. For example the word /všude/ is phonetically [fšude] because the voiced [v] assimilates to the unvoiced [š]. Similarly word-final voiced consonants, be they post-vocalic or post-consonantal, undergo de-voicing. Thus a word like /hrad/ is pronounced [hrat] and the adopted word /víkend/ is [vi:kent]. When inflected these phonemes assume their underlying form (e.g. [hradi]; [vi:kendi]). English paired consonants generally do not assimilate in any position (e.g. /shipbuilding/ [šipbildiŋ], /good time/ [gʊdtaim]).

In summary, the consonants of Czech and English may differ in realization (place and manner of articulation), distribution in word positions, frequency and weighting, contrasts within the system, and assimilation. These factors allow the Czech language to combine consonants in ways which are impossible in English. Both the preliminary analysis of syllable-number differences as well as Skaličková's (1974) phonemic analysis, give reason to believe that Czech should have a richer repertoire of cluster-onsets. However, to the knowledge of the author there is no evidence to support this assumption. A comparison was therefore undertaken in two steps. A pilot study was carried out to establish whether large enough differences existed in the frequency and variety of word-initial clusters to warrant a more detailed examination. A more complete analysis was then performed in order to qualify and quantify the differences. Word-final clusters were also examined in the preliminary study, because performance on these units was evaluated in the Nonword Spelling task.

Pilot Study

The first analysis involved counting cluster-onsets and word-final clusters in passages of children's and adults' texts. Two children's texts taken from children's fiction and two adults' texts taken from a novel and a magazine article were chosen in each language. Passages of 200 words were randomly selected from each text and all words containing cluster-onsets and word-final clusters were recorded. The cluster-onsets and word-final clusters were analyzed separately.

Word-initial Clusters

The tokens, or the number of words containing cluster onsets, occurring in the text were counted. All clusters were classified phonetically, not orthographically. For example the entries /sk/ (as in 'sky'), /sc/ (as in 'scalp'), and /sch/ (as in 'school') were all classified under the same cluster [sk]. Next, repetitions of identical words were subtracted from the tokens to establish the number of types, or number of *different* words containing cluster onsets. Tokens and types were expressed in terms of percentage of occurrence in a two hundred word text. Finally, within each language, the results of both child texts and both adult texts were combined.

The results were strikingly similar across text types (child-adult) within languages. In Czech, 22% of the words in the children's texts contained cluster-onsets (tokens), of which 19% were different words (types). The adult texts contained 23% token cluster-onsets and 20% types. Of the total English children's corpus, there were 12% tokens and 6% types for onsets while the adult texts contained 6% tokens, 6% types. This calculation produced a Czech-to-English type ratio of 3.25 : 1. These results provided initial empirical support that the Czech language contains a higher frequency of word-initial consonant clusters.

Word-final Clusters

Any string of consonants following the vowel of a word-final syllable was counted as a cluster unless one of the consonants was syllabic. The words 'malt' and 'spilled', for example, finished with the clusters [lt] and [ld] but the words 'ladle' and 'sombre' were not considered clusters because the [ɫ] in the syllable /dle/ and the [r] in the syllable /bre/ were the heads (or vocalic segments) of the syllable.

As in the word-initial analysis, types and tokens were calculated within languages and across text-types. In this analysis, the English texts contained far more clusters at word ends than the Czech texts. Twenty-four percent of the English adult texts contained words with word-final clusters, 17% of all words being distinct types. The child texts contained 13% tokens and 7.6% types. Only one word-final cluster was found in the combined Czech adult texts, representing 0.25% (tokens and types) of the total. The children's texts contained 2.6% tokens and types. The type ratio of English to Czech was 8.6 : 1. Thus, whereas Czech is richer in word-initial clusters, English contains more clusters in the word-final position.

Complex Onset Frequencies in English and Czech

Method

Materials

This analysis was carried out to replicate the first, but also to serve as a guide to creating the stimuli for the main study. A word frequency book was used for each language in order to calculate the types, tokens and frequencies of word-onset clusters. The English source, Computational Analysis of Present-day American English (Kučera & Francis, 1967) is a corpus of 1,014,232 words drawn from 500 samples of natural text, each approximately 2,000 words in length. The Czech source, Frekvence Slov (Word Frequency) (Jelínek, Bečka, & Tesitelová, 1961) is very similar in construction, on a somewhat larger scale. It is based on a corpus of

1,623,527 words from 75 publications in eight categories (prose, poetry, youth literature, drama, specialized literature, journalism, scientific literature, and oral presentations). Unlike the Kučera and Francis count, the Czech samples varied in size as every word in each publication was tabulated.

Procedure

The tokens, frequencies, and types of word-initial clusters were obtained as follows. From the alphabetized list in each corpus, every word-initial cluster was recorded in its phonemic representation. The number of tokens (number of times a cluster occurred) was calculated by adding all the entries beginning with a particular cluster. Proper nouns, compound nouns and foreign words, however, were not included in the count. For example, 424 entries began with the cluster /br/ in the English corpus, therefore /br/ had 424 tokens.

With each consonant cluster, a frequency of its occurrence in the corpus was also provided. These frequencies were summed, giving a cumulative frequency for each cluster. Thus the /br/ cluster had a cumulative frequency of 1,561/1,014,232 in the Kučera and Francis count .

Types were calculated in order to avoid selecting clusters which may be very frequent in a language yet be representative of only a few high frequency words. The number of types was derived from the tokens using some of the guide-lines proposed by Nagy and Anderson (1982). Inflected words which produced transparent derivations of the "base word" were considered instances of the same word. The tokens, 'predict', 'predicted', 'predicts', 'predicting', 'prediction' were all counted as one type ('predict'). Words linked by etymology and form but having rather opaque semantic links were evaluated according to the closeness of their most familiar meanings. For instance, although "blockage" is clearly a derivative of 'block', the two words have separate dictionary entries in both the Oxford American Dictionary (1982) and Webster's New Collegiate Dictionary (1976). The first meaning of 'block' is a solid piece of wood, stone or some other hard substance. The definition of 'block' in the sense of obstruction, which is of course the closest semantic link to 'blockage', is the last of seven or eight definitions of the noun 'block'. The two words were therefore counted as single tokens of distinct types.

Results

Based on the above sources, 258 different word-onset clusters were found in Czech and 31 in English. These are listed with the appropriate statistics in Appendix B. This analysis produced an even larger ratio of clusters (8.3 : 1) between Czech and English than was found in the pilot study. Furthermore, in Czech, the number of word-initial consonant clusters increased to 351 cluster types when those combinations containing the syllabic consonants ([r̩], [l̩], [m̩]) were included. However, because this study was concerned with onsets proper, clusters containing consonants which figured as syllable heads were excluded. Despite this constraint, Czech clearly provides a much larger variety cluster-onset input from the speech stream.

A further inspection of the results showed that not only are onset clusters more varied in the Czech language, but they are also far more frequent . For example, the most frequent cluster in both languages was /pr/ yet its cumulative frequency was 11,661/1,014,232 (or 11,497/1,000,000) in English and 40,738/1,623,527 (or 25,092/1,000,000) in Czech. The tenth most frequent cluster-onset in Czech, [hl], had a frequency of 8,069/1,623,527 (or 4,970/1,000,000) whereas the tenth most frequent cluster [sp] occurred 3,118/1,014,232 (or 3,074/1,000,000) times in English.

Chapter III: Method

Subjects

Sixty Czech and 60 English speaking Canadian children participated in the study. In each language group there were 30 kindergarten and 30 grade one pupils. At each grade level, 18 children received all tests in their native language and 12 children received all tests in the foreign language. For example, 12 Czech kindergarteners were given the English tests and 18 were given the Czech tests. Subjects were randomly assigned to the test condition. The mean ages of the subjects by grade level and country are given in Table 1. In every group, the mean age of the Czech children was two to five months older than their Canadian counterparts.

Table 1

Age Means (and Standard Deviations) by Grade, Nationality and Test Condition

	Grade	
Group	Kindergarten	Grade One
	Canadian	
Native-language	5.95	6.82
(n = 18)	(.31)	(.50)
Foreign-language	5.83	7.01
(n = 12)	(.53)	(.40)
	Czechoslovakian	
Native-language	6.17	7.38
(n = 18)	(.58)	(.38)
Foreign-language	6.39	7.21
(n = 12)	(.66)	(.49)

All subjects attended middle-class suburban schools of large cities - Prague in the case of the Czech subjects, Montreal in the case of the English-Canadians. In view of the societal differences of the two countries, it is difficult to compare socio-economic status on a standardized scale.

It should be noted that testing in Czechoslovakia took place in April, 1990, only four months after the "Velvet Revolution" at which point no significant changes had yet affected either the primary school system or the employment structure. Therefore, the subjects and their home backgrounds can be described in terms of the norms of the preceding four decades. Children in the Czech samples typically came from families where both parents were working, they lived in a company or state-provided apartment, and the children attended an educational institution from nursery through post-secondary school. In Czechoslovakia, the average family is well fed, housed, and medically provided for. In the most basic aspects of life, the Czech subjects appear to be comparable to the Canadian middle-class population.

General Selection Criteria

Children were excluded from the study if they spoke more than one language, suffered hearing loss or abnormal speech development. Information regarding exclusionary criteria was obtained from teachers, school records and the children themselves.

The criterion of monolingualism posed no problem in the Czech groups both because Czech society is linguistically homogeneous, and because second language instruction does not begin until grade four in the regular schools. This is not the case for Anglophones in Quebec, especially not in and around large urban centres. In English schools, second language (French) instruction begins as early as preschool. For these reasons the definition of monolingualism had to be somewhat looser in the selection of English-speaking subjects. All the English subjects had some exposure to French in their second-language classes. Nonetheless, precautions were taken to exclude any fluent French-speakers. All children were asked what language they spoke at home; those who were exposed to a language other than English were not included in the study. Those who answered that they spoke English, were then asked the meanings of some words in French as well as several simple questions in French about their name, grade, teacher, etc. Children who were able to converse fluently were excluded. Most children, however, could do no more than say a few basic vocabulary words.

Prior to testing, all kindergarten children were given a short reading test in order to eliminate those children who could read. The following words were chosen from grade one primers: English - 'end', 'bad', 'day', 'go', 'see', 'sun'; Czech - 'pes' ('dog'), 'dům' ('house'), 'sova' ('owl'), 'pila' ('saw'), 'balík' ('package'), 'slovo' ('word'). Children who could read more than three words by sight or by decoding were excluded from the study. Children who were unable to read or recognize the three-word-minimum were considered nonreaders and went on to the first task.

Selection of Czech Subjects

The school board was assigned to the researcher by the Czech Ministry of Education and participating schools were assigned by the director of the school board. No parental consent was required as long as the principals and teachers concerned agreed to participate in the project. However, the decision to participate was ultimately made by each child. The kindergarten children came from three kindergarten schools. These schools cater to three-, four-, and five-year-olds and are separate from the primary schools. They are open from eight to twelve hours per day. In the morning, children engage in a structured programme and in the afternoon, they nap and then have free-play. Attendance, although not obligatory, is very high due to the number of working mothers.

The first graders were selected from three classes of two elementary schools which house grades one to eight. These children have approximately four hours of instruction per day. In the afternoons, the schools provide a day-care where most children remain until three or four o'clock. There is no formal instruction in the day care setting; games and outings are the central activities but children are also encouraged to do their homework and are helped if necessary.

Selection of English Subjects

For the English-Canadian subjects, consent of the school and parents was required for each child's participation. The kindergarteners came from three public elementary schools and were attending a regular half-day programme. All children were exposed to French language instruction for approximately 30 minutes per day. The curriculum is otherwise comparable to the Czech system in that both approaches avoid direct instruction and generally focus on motor, verbal and social development in a semi-structured milieu.

The grade one children came from four classes of two public elementary schools. The children receive on average five hours of instruction, including 30 minutes per day of French.

Tasks

Three phonological awareness tasks and one spelling task, all of which manipulated word-onsets, were created for the experiment. The phonological tasks involved making judgements about the similarity of the onsets of words (Same-Different), producing the first sound of monosyllabic words (Sound Isolation) and deleting the first phoneme of a three phoneme word (Phoneme Deletion). All tasks, including spelling, were composed of nonword items in order to control for previous knowledge of word spellings and for frequency of occurrence of real words in the two languages. Such knowledge could influence the results in that the children may be relying on memory of spellings to manipulate graphemes rather than concentrating on the sounds and manipulating phonemes. Two of the tasks, Same-Different and Nonword Spelling, contained CCVC and CVCC items whereas the other two, Sound Isolation and Phoneme Deletion, contained CCV and CVC items. A Czech and an English version of each oral task was constructed; both were balanced for cluster types and/or frequency. There was only one version of the Nonword Spelling test that was given to both language groups.

The following guide-lines were adhered to for the purpose of maximally equating the English and Czech tasks. First, as many different clusters as possible (the same number in each language) were included in each form. Second, highly frequent clusters in both languages were used to create the stimuli. This criterion was necessary to ensure that the speech sounds in the stimuli actually reflected typical input, and, that the children were familiar with them. Third, cluster onsets, similar in acoustic and/or articulatory features in both languages were used to ensure that the children in both language groups were being asked to manipulate items of equal complexity.

From an inspection of Appendix B, it is clear that if every item were to meet *all* the criteria, the number of test items would be very small. The clusters which are frequent in both languages *and* share a virtually identical pronunciation are: [st], [sk], [sp], [sl], [sm]. Evidently, the use of this group alone would rule out the criterion of sampling across a wide variety of cluster types. The complications posed by discrepancies in frequency and phonemic realization in phonemically identical stimuli are discussed in Chapter II.

In view of the limitations, it was impossible to meet all criteria simultaneously. Therefore, the criteria were relaxed by including some items which were highly frequent in both languages, and that were similar in acoustic and articulatory properties as well as items which exploited the variety of cluster combinations in each language. Naturally some items satisfied more than one criterion. For example the highly frequent English cluster, [fr] is matched with the highly frequent Czech cluster [vr] so that not only frequency but also some major-class features (place and mode of articulation) were shared. Those clusters that had no close counterparts across languages were matched for frequency only.

Lastly, two language-specific phonemes were included in each test in order to increase sampling. On the English form, [θ] and [W] (which do not exist in Czech) appeared in the onsets [θr], [θw], [sw], and [dw]. The Czech form contained the language-specific onsets [χr], [tř], [χl], [χv], where [χ] and [ř] do not exist in English. Each of these clusters appeared once on the Same-Different task (the task requiring the greatest number of items). The Isolation task made use of [θr] and [χr] while the Deletion task contained [tw], [θr] and [χv].

Same-Different

The Same-Different task consisted of 20 CCVC and 20 CVCC nonword pairs. Of the 20 CVCC pairs, 10 shared the onset (e.g /semp/-/soold/) and 10 did not share the onset (e.g. /darp/-/mont/). The 20 CCVC nonword pairs were divided into 10 pairs that shared the first consonant of the onset (e.g. /flas/-/freb/) and 10 pairs that did not share any part of the onset (e.g./glek/-/stin/). The nonwords sharing onsets and parts of onsets were referred to as *same* pairs, those not sharing part or whole onsets were the *different* pairs. The *different* pairs were used to control for guessing and response bias, and were not included in the analysis.

The 40 pairs were evenly divided into two 20-item blocks, each containing five CCVC *same* pairs, five CVCC *same* pairs, five CCVC *different* pairs and five CVCC *different* pairs. The order of all pairs was randomized. The blocks were administered on separate days. Out of the 20 *same* pairs, the Czech and English tests shared four pairs of similar CC onsets ([bl] - [br], [st] - [sm], [pl] - [pr], [sk] - [sk]) and seven pairs of similar C onsets ([p], [s], [s], [b], [s], [d], [t]). The remaining nine items contained either language-specific phonemes or language-specific consonant combinations. The task was administered to all kindergarten and grade one children. The stimuli are presented in Appendix C.

The child was told that he/she was going to play a game with some pretend words. He/she was going to hear two funny words and had to decide whether they sounded the same at the beginning or not. The experimenter, then, gave three examples and provided the answers. For example: "Do /krin/ and /klav/ begin the same way? /Krin/, /klav/ (slight pause). Yes, they have the same beginning of [k]". Then the child was asked to try a few alone. Five practise trials were given. Children who did not understand or who asked for more practise were given the demonstration trials and the practise trials again. The practise set was only repeated up to two times completely. The children were then reminded that they were to listen carefully and answer "same" if the words began the same way and "different" if they did not. The administration of the test followed. The same training procedure was repeated for both blocks.

The task required an answer of "same" (any affirmative answer was accepted) or "different" (any negative answer was accepted) to every target pair. For each correct response, the child was accorded one point; for each incorrect response a zero. The points were tallied for each correct response for a total out of 20 on each block and the results of the two blocks were then combined. The means for the negative items were examined; however, only the scores on the 20 "same" pairs (10 CCVC and 10 CVCC) were retained for analysis.

Sound Isolation

The Isolation task contained 20 nonwords; 10 items had a CCV structure and 10 items had a CVC structure (see Appendix C). The stimuli are such that the consonants of the CCVs also occurred but in different positions in the CVCs, e.g. /slau/, /saul/. The same vowels were the same in these pairs unless they formed a real word in which case another vowel was chosen. Again, attempts were made to balance the items across languages with respect to cluster frequency and phoneme comparability. Of the 20 items, six CCVs ([sl], [tr], [kl], [pl], [br], [dr]) and six CVCs ([s], [t], [k], [p], [b], [d]) shared onsets on both tests, four CCVs were language-specific either phonemically or in the combination of consonants, and, one CVC had a language-specific onset (English: [θ]; Czech: [χ]). The order of all items was randomized. The Isolation task was given to all children in both age groups.

The subjects were introduced to a puppet who spoke a pretend language. The puppet liked to play word games, especially finding the sounds in pretend words. But there was one word game he/she (depending on the child's sex) was not very good at yet -

"the one where you say the FIRST sound of a word". The puppet then asked the child, "Can you show me how to figure out the sounds at the beginnings of words?". The experimenter added, "I will show you how to play first. I am going to tell you a pretend word, you will repeat it after me and then you will tell the puppet the first sound of the word. I'll show you a few first". The child was then given three examples such as "Here's the funny word /zat/. The word /zat/ begins with a [z] sound". The child was asked to try a few examples and it was stressed that he/she had to repeat the nonword first in order to ensure that the word was heard correctly, and only then say its first sound. Four practise items were presented (two CCV and two CVC). If the child needed more practise trials the experimenter repeated the procedure up to two times. As the task was administered, the children were reminded to repeat the word first, and to say the first sound *not* the first letter. All responses were recorded by the experimenter.

Only the initial *sound* of the target word was considered a correct answer. Thus if the *name* of the first letter was given, it was considered incorrect. Correct responses were tallied for a total score out of 20. Children in the foreign-language condition systematically produced several assimilation errors at both age and language levels. These errors occurred on the language specific-items. As was already explained these items contained phonemes foreign to the second language group. Because these items were foreign to them, it is natural that children had considerable difficulty reproducing these sounds. A typical example of an assimilation error on the English test by the Czech children was the production of [f] as the initial sound of the targets /threy/ and /their/. Only two Czech children correctly produced the [θ] sound. However, most produced [f] and a smaller group produced [s]. On the Czech test, the most difficult items were the targets /chrá/ and /chár/ which require the phoneme [χ]. The English children typically responded with a [k] as the initial sound, a smaller group gave [h]. Because the target sounds were foreign, all children who replaced them with the next closest sounds in their native languages, were credited with a correct response.

Phoneme Deletion

The Deletion task was administered to the grade one children only. This was because it has been found in previous research (Bruck, personal communication; Stanovich et al., 1984) that English kindergarteners are unable to perform deletion on simple CVC items. The task consisted of 16 nonwords, eight of which were CCVs and eight were corresponding CVCs (e.g. /sla/-/sal/) presented in random order (Appendix C). On the Czech test, one CCV and its corresponding CVC contained a language-specific phoneme (/chrá/ [χrá], /char/ [χar]) and two CCVs contained a language-specific combination of phonemes (/čle/, /vlé/). On the English test, two CCVs (/twa/, /thra/ [θra]) and one CVC (/thom/ [θom]) contained language-specific phonemes. All other combinations were common to both languages .

The children were told that they were going to play another word game with pretend words. They would hear a pretend word and repeat it. Then they were to figure out the first sound of the word. Finally, they were to take away the first sound and say what is left of the word. The experimenter gave each demonstration trial as follows:"If I say a funny word like /mab/, what's the first sound of /mab/? It is the [m] sound. Now if I take away the [m] from /mab/, I'm left with /ab/ ". The children were given four demonstration items and four practise trials. Additional trials were given as necessary but the entire set was repeated maximally two times.

Children were accorded one point for every correct answer. Correct responses were tallied for a total score out of 16. The children in the foreign language condition often distorted the sounds of the nonword responses. When responses were close approximations to the target sounds (for example a Czech child's response of [wi:] instead of the English [ri:]) they were considered correct.

Nonword Spelling Test

The spelling test was administered to the grade one children only. It was a list of 18 nonwords: nine CCVCs, nine CVCCs. However two words had to be discounted due to experimenter error. Hence, only 16 items (eight CCVCs, eight CVCCs) were analyzed. Since this task was *unilingual*, only clusters which are legal in both languages were used. This constraint reduced the choice of possible clusters and therefore, clusters of varying frequency in both languages were selected. The same list was used with both language groups but the graphemic representations differed on some nonwords. The word shork [šork] for example, requires a digraph sh to represent the [š] sound in English while it is represented by a single grapheme š in Czech. However, those consonantal sounds requiring a digraph in English, need a diacritic marker in Czech, so that the number of symbols the children had to produce for any consonant was the same. Also, long vocalic phonemes requiring two graphemes to represent the sound (e.g. ee or ea as in smeed) in English require an accent in Czech (e.g. í in smíd). Looked at in this way, there were three words in which the Czech children had to write an extra symbol : [ba:rt] = bárt, [ka:rm] = kárm, [po:lt] = pólt. This difference was not problematic, however, as vowel spellings were of secondary importance to this study. The same graphemic representation was possible for English and Czech on seven of the 16 nonwords (flas, styn, sneg, semp, sont, fils, brel) while pronunciation differed to varying degrees in all words .

The test was written on a sheet of paper with 18 lines. Each line was preceded by an icon which was used as a reference point (rather than a line number). Care was taken to use icons that could not be used as cues to the spellings. For example on the line identified by a tree the given word did not contain any of the phonemes in the word 'tree'. The list of words is presented in Appendix C.

The spelling task was administered to groups of three or four children. The children were seated at separate tables and were given their spelling sheet. It was explained that this was not a real spelling test, in fact the words were not real words and therefore should be spelled the way the child thought most appropriate. The subjects were to listen to each word very carefully and then to write exactly what they heard. There was no right or wrong spelling to these words. They were then told, for example, "on the *bird* line write the word 'semp' ". Each word was repeated three times, but if a child asked to hear it again it was repeated. The experimenter waited for all children in the group to finish before going on to the next word. The pronunciation of the items was English-like for the Anglophones and Czech-like for the Czechs.

The scoring of the Nonword Spelling task was carried out as follows. First, all spellings were evaluated in reference to a prototype of each target word. The decision was made to accept the orthographic representations of any graphemic *symbol* that could legally appear within a word context of a child's native language (although not necessarily in the context of of the target word). In addition, three other types of consonant errors were not penalized: (1) The omission of diacritic markers in the case of the Czech children (e.g. s instead of š) and the omission of one member of a digraph in the case of the English children (e.g. s instead of sh). As long as an attempt was made to represent the consonant, the child was credited with a correct response. (2) The reversal of letters in the case of the English children (e.g. d instead of b). Because English-Canadian youngsters are taught to print prior to learning cursive writing, a common error for beginning spellers is letter inversion. Czech first-graders are taught cursive writing which leaves little opportunity for reversals (in effect none occurred). (3) Errors of phonological neutralizations which occurred mainly in the Czech group. These errors occurred with certain consonants in combinations which are infrequent or which become neutralized especially in the word-final position. Words containing a word-final t, for example [sont] , [plu:t] , [ba:rt] , [po:lt] were spelled by some children as sond, plúd, bárd, póld. Real-word analogs such as 'hrad', 'plod', 'med' are phonetically [hrat], [plot], [met]. Since the children's spellings were actually underlying representations of real-word analogs, they were accepted as correct. Similar errors occurred among the Anglophone subjects where three children spelled the sk in [sku:m] as sg. Although not very frequent in English, this type of assimilation of sounds can occur, in a word like 'disguise' [diska:jz], for example. Although this is a two-syllable word where the onset of the second syllable is in fact a single consonant, it is conceivable that the children were using [sgu:m] as the underlying representation and therefore were not penalized.

The Czech evaluation was stricter in the sense that virtually no departure from the prototype was accepted. Czech orthography is fairly transparent in its sound-symbol links and for most sounds the relationship is one sound to one symbol. Furthermore, with the exception of the four stimuli above, none of the nonwords could be interpreted as having different underlying representations. The English evaluation was more lenient because the head of almost every target syllable could be represented with several different vowels or vowel combinations. For example, three children wrote chroc for the target [šru:k]. Reading this word evidently produces phonemes other than the target. However, the ch can have the [š] pronunciation in a word like 'châlet' a single o can be read as [u:] in the word 'lose', and, of course c is frequently used to represent the [k] sound. Another word that elicited a large range of interpretation was [su:ld] with versions such as: soolde, sowled, sulde, sowld, among others. All of these interpretations were accepted. It should be noted that bulk of this sort of variation occurred in the spellings of vowels which were not the focus of the study.

For each misspelled item, the following types of consonant errors were coded: (1) consonant substitutions, for example šlúk for the target [šru:k]; (2) consonant omissions, for example bel for the target [brel]; (3) vowel insertions between the cluster segments, for example falas for the target [fla:s]. Any such error in the onset and/or coda - be it a cluster or a singleton - was penalized. When two types of errors were committed in clusters they were considered a single error in the onset or coda in the data set for consonant errors. For example ras for the target [fla:s] contained both a substitution and an omission, however it was counted only one error in the analysis of onset errors.

Procedure

Blocks I and II of the Same-Different task were counterbalanced for each group so that half of the subjects received block I on day one and block II on day two and half received the reverse. In the same way, the day and order of administration of the Isolation task was counterbalanced for all groups. Thus the kindergarten children either received one test on day one (one block of the Same-Different task) and two tests on day two (the second block of the Same-Different task and the Isolation task) or vice versa. In grade one, the same procedure was followed with the addition of the Deletion task so that all grade one children were given one block of Same-Different plus the Isolation or Deletion task on day one and the second block of Same-Different plus the Isolation or Deletion task on day two. The time period between testing was two to four days. The Nonword Spelling task was carried out after the completion of all other testing.

Testing was carried out in March, 1990 with the English children and in April, 1990 with the Czech children. The first-graders were tested in the last two weeks of March and the first two weeks of April in order to test both groups at more or less the same stage in the school year.

Chapter IV: Results

Data Analysis

The study was designed to compare English- and Czech-speaking children on matched phonological awareness tasks. Thus, for each task, the first analysis involved a comparison of the two language groups taking the tests in their native language. All data were analyzed across subjects with three-way repeated measures analyses of variance. The between-groups factors were language (Czech versus English), and grade (kindergarten versus grade one); the within-groups repeated measure was syllable structure.

Although the English and Czech versions of each task were balanced as much as possible on several dimensions, the possibility remained that the tests were in fact not of equal difficulty in some way. Czech children may perform better than English children not because they have better phonological awareness but because the Czech test is easier than the English test. In order to examine this possibility, it was decided that in the case of main effects of language (here language refers to the language of the speaker not of the test) or interactions with language, cross-test analyses would be carried out. That is, the scores of the 12 children who had taken the foreign-language forms were compared to the scores of the children who had taken the tests in their native language. For example, the scores of the English children taking the English test were compared to those of the English children taking the test in Czech. It was assumed that a combination of equating the tasks (as described earlier) as well as the administration of both the English and Czech forms to each language group would provide sufficient information about task comparability and group performances.

If the Czech children performed better than the English children on tests taken in their native language, and if the differences are due to higher levels of phonological awareness, then a comparison of Czech native-language versus foreign-language groups should yield no effect of test version, and, the same should be true of a comparison of both English groups. If, on the other hand, the Czech children fared better on the native-language task because the Czech form was easier, the English-speaking children would be expected to achieve higher scores on the Czech test whereas the Czech children should show poorer results on the English form than their Czech peers taking the Czech form. Generally lower scores were expected from the foreign-language groups given the added handicap of foreign-sounding stimuli but the magnitude of the disadvantage was expected to be equal for both groups. Furthermore, it was expected that if test forms were well equated, then children should show the same pattern of performance on CCV and CVC items in each phonological awareness task whether they took the test in their first language or in the foreign language.

The alpha level of significance was set at .05 for every analysis. Interactions were examined using the Tukey HSD procedure for within-group and between-group comparisons. Within-group tests always measured the simple main effect of syllable structure whereas the between-group tests measured differences in each onset type separately (for example the difference between Czech and English subjects on CCV items).

Same-Different

Native language comparison

The overall correct responses on "different" items was first inspected. The English kindergarteners ($\underline{M}$ = 96.67%), first graders ($\underline{M}$ = 96.67%) and Czech first graders ($\underline{M}$ = 96.94%) had virtually identical means. Only the Czech kindergarteners ($\underline{M}$ = 91.94%) differed somewhat from the other groups. The near-ceiling performances indicate that most children attended to the task without difficulty.

For the number of correct "same" items, a three-way analysis of variance with repeated measures was carried out. The factors were language group (Czech versus

English) and grade, the repeated measure was syllable-structure (CCVC versus CVCC). There was a main effect of grade, $F(1,68) = 60.237$, $p < .0001$. Kindergarten children's performance ($M = 60.0\%$) was lower than that of the first grade ($M = 93.1\%$). The effect of syllable-structure was also significant, $F(1,68) = 7.798$, $p < .01$, with CCVC items ($M = 74.4\%$) more difficult than CVCC items ($M = 78.6\%$). There was no main effect of language and no significant interaction effect. The mean percentage correct for each grade and language group is reported in Table 2.

The results indicated that the Same-Different task elicited relatively small (although significant) differences between CCVC and CVCC items. The absence of a language effect suggests that English and Czech children's ability to match complex syllable patterns is similar although the means in Table 2 show that the Czech kindergarten children had somewhat (but not reliably) more difficulty with the the task than their Anglophone peers. Both groups of first graders, on the other hand, performed similarly and both performed near-ceiling. The results also suggest that test versions were not an intervening variable on this task.

Table 2

Same-Different Task:Percent Correct (Standard Deviations) on Same Items for the Native Language Comparison

	Language of subjects			
	English		Czech	
Grade	CCVC	CVCC	CCVC	CVCC
Kindergarten	61.1	65.6	54.4	58.9
	(22.2)	(24.6)	(25.7)	(26.3)
Grade one	91.1	96.1	91.1	93.9
	(13.7)	(6.1)	(10.8)	(11.9)

Isolation

Native language comparison

A three-way analysis of variance with repeated measures was carried out on the number of correct items. The between-group factors were language and grade, the within-group repeated measure was syllable structure (CCV versus CVC). There were significant main effects of grade, $F(1,68) = 9.511$, $p < .003$, and syllable structure, $F(1,68) = 51.609$, $p < .0001$, as well as significant interactions of syllable-structure by grade, $F(2,68) = 10.663$, $p < .01$, and syllable-structure by language, $F(1,68) = 10.663$, $p < .01$ (see the top half of Table 3 for means and standard deviations).

Table 3

Isolation Task: Percent Correct (Standard Deviations) for the Native Language Comparison (upper half) and for the Foreign Language Comparison (lower half)

	Language of subjects	
Grade	English	Czech
	Native Language Condition	
Kindergarten		
CCV	73.3 (22.5)	80.0 (26.1)
CVC	93.3 (15.0)	91.1 (24.0)
Grade one		
CCV	88.9 (13.2)	97.2 (11.8)
CVC	100 (0.0)	9[illegible].8 (5.4)
	Foreign Language Condition	
Kindergarten		
CCV	65.0 (28.1)	67.5 (35.5)
CVC	86.7 (23.1)	71.7 (34.6)
Grade one		
CCV	89.2 (12.4)	94.2 (6.7)
CVC	96.7 (6.5)	98.3 (3.9)

The Tukey HSD pairwise comparisons test was used to examine the age by syllable structure interaction (Figure 1). The CCV items were more difficult than CVC items for the kindergarten children ($p < .01$), but the difference was not significant for grade one children. Between age group comparisons indicated that six-year olds were significantly better than five-year olds at isolating both CCVs ($p < .01$) and CVCs ($p < .05$).

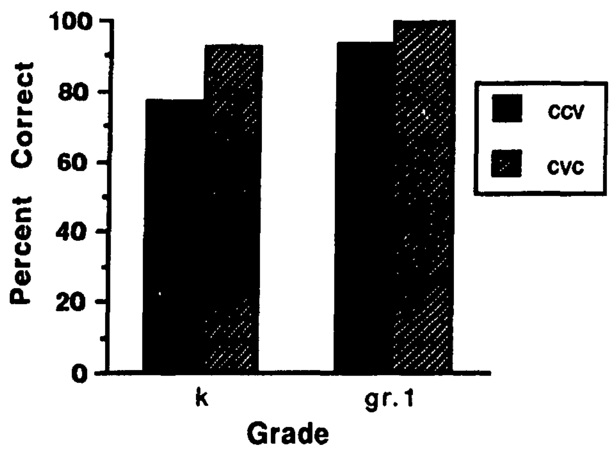

Figure 1. Isolation Task: Percent correct for each syllable structure in kindergarten and grade one.

Of more interest is the syllable-structure by language group interaction (Figure 2). The Tukey HSD pairwise comparisons procedure revealed syllable-structure effects in both the English group ($p < .01$) and in the Czech group ($p < .05$). Between-group tests showed the English children scoring significantly lower on CCV items ($p < .01$), while no differences occurred on the CVC items. Thus, while English children have more difficulty manipulating cluster onsets, Czech and English-speaking children fare equally well on singleton onsets.

It was possible, however, that the Czech children were better at segmenting CCVs because these items were easier on the Czech test. If the tests were of equal difficulty, English children should continue to find CCV items more difficult on the Czech version, and, the Czech children should find the CCVs no more difficult on the English form than on the Czech form. In order to test these hypotheses, the data of the 18 English children taking the English test were compared to the data of the 12 English children taking the Czech version of the test. The same analysis was then carried out on the Czech children's data.

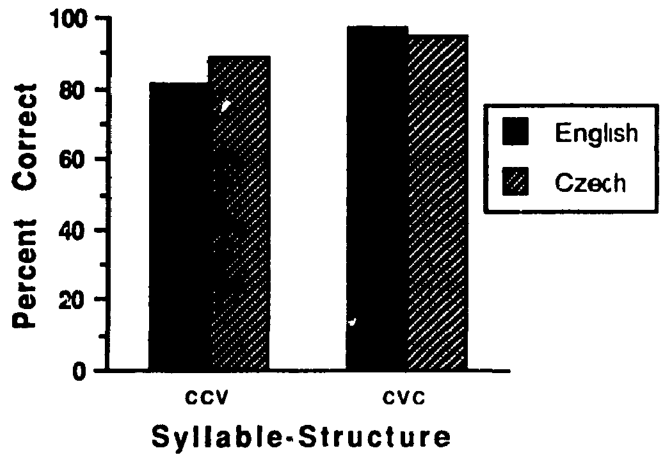

Figure 2. Isolation Task:Percent correct for each syllable structure by Anglophone and Czech children.

Cross-test comparison

The data of all English subjects were submitted to a three-way repeated measures analysis of variance. Despite unequal sample sizes, the homogeneity of variance assumption was not violated ($F>1$). The between-group factors were test-type (English versus Czech) and grade; the repeated measure was syllable structure (CCV versus CVC). The means and standard deviations for groups taking the foreign-language test are reported in Table 4. The analysis yielded a main effect of grade, $F(1,56) = 13.126$, $p < .001$, and syllable-structure, $F(1,56) = 47.659$, $p < .0001$. Syllable-structure interacted with grade, $F(1,56) = 6.972$, $p < .01$, but no effects of test-type were significant.

Post hoc comparisons by Tukey tests yielded a significant effect of syllable-structure in the kindergarten group ($p < .01$) and in grade one ($p < .05$). Between age groups, the kindergarteners were significantly lower on CCVs ($p < .01$). There was no difference on CVCs however (see Figure 3).

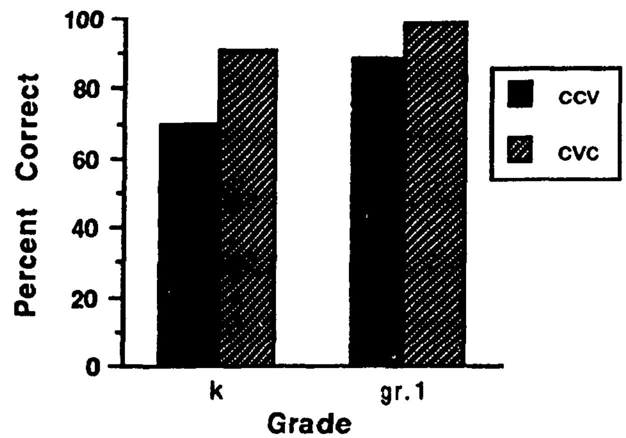

Figure 3. Isolation Task:Percent correct on each syllable structure in kindergarten and grade one.

The Czech children's data were submitted to the same analysis. The assumption of homogeneity of variance was not violated ($F>1$). There were significant effects of grade, $F(1,56) = 12.635$, $p < .001$, and syllable-structure, $F(1,56) = 9.317$, $p < .0001$, such that the kindergarteners ($M = 79.2\%$) scored significantly lower than the first-graders ($M = 97.0\%$), and, all children performed better on CVC items ($M = 90.7\%$) than on CCV items ($M = 85.5\%$). Neither the effect of test-type nor any interaction was significant.

The absence of test-type effects lends further support to the hypothesis that the Czech children's higher scores on CCV items was not caused by a facilitating effect of the Czech stimuli. Regardless of test version, the trend among Czech-speakers and English-speakers is the same.

Unlike the Anglophones, Czech subjects did not show an age by syllable-structure interaction. Five- and six-year olds followed the same trend from one onset type to the other. This finding is in accordance with the word-class gains reported in the native language analysis. Whereas Czech children show a relatively small increase from complex onsets to simple onsets, English children show large differences. That these differences are most evident among kindergarteners, is explained by the near-ceiling effects in grade one (although even in grade one Anglophones show larger differences than the Czechs).

Deletion

Native-language comparison

The Deletion task was administered to the grade one groups only. The data were submitted to a two-way repeated measures analysis of variance. The between-group factor was language of the children (English versus Czech) and the repeated measure was syllable-structure (CCV versus CVC).

There were main effects of language, $F(1,34) = 13.552$, $p < .001$, and of syllable structure, $F(1,34) = 30.646$, $p < .0001$. The language by syllable-structure interaction was significant at $F(1,34) = 23.627$, $p < .0001$. The means by language group and syllable-structure are reported in the upper half of Table 4.

Tukey HSD post hoc comparisons were carried out to test word-class differences within language groups as well as between groups for CCV and CVC items. The effect of syllable-structure was significant ($p < .01$) for the English children but not for the Czech group. The Czech children performed significantly better on CCV items than their Anglophone counterparts ($p < .01$), but the groups did not differ on CVCs.

The language by syllable-structure interaction necessitated further analyses to examine whether the superiority of the Czech subjects was due to advanced metalinguistic development or to easier items on the Czech test. Hence the results of all the English-speaking subjects were compared across test conditions and the same analysis was carried out on the Czech data.

Table 4

Deletion Task: Percent Correct (Standard Deviations) for the Native Language Comparison (upper half) and for the Foreign Language Comparison (lower half)

	Language of the Subjects	
Syllable structure	English	Czech
	Native Language Condition	
CCV	38.88	86.11
	(26.5)	(18.8)
CVC	92.36	89.59
	(10.9)	(16.5)
	Foreign Language Condition	
CCV	38.54	76.04
	(24.3)	(18.8)
CVC	81.25	85.41
	(18.8)	(19.0)

Cross-test comparison

The results of all English-speaking children were submitted to a two-way analysis of variance with test-type (English versus Czech) as the between subject factor and syllable-structure (CCV versus CVC) as the within subject repeated measure. The test for homogeneity of variance showed that the two groups did not differ significantly ($F>1$). There was a strong effect of syllable-structure, $F(1,28) = 54.123$, $p < .0001$, such that, aggregating over test-type, the CCV items ($M = 38.75\%$) were more difficult than the CVC items ($\underline{M}$ = 87.91%). The effect of test-type and the test-type by syllable structure interaction were not significant.

The same analysis of the Czech children's results produced no significant differences. Czech children did not find cluster onsets any more difficult to manipulate than singleton onsets and they performed as well on the English test as they did on the Czech test. The means of groups in the foreign-language condition are reported in the lower half of Table 4.

Neither set of results suggests that the differences between language groups were an artifact of the Czech test. Whether the children were given the stimuli in their native language or in the second language did not change their performance. The Deletion task showed Czech children consistently higher on the CCV items than their English peers, but all children performed within the same range on the CVC items.

Nonword Spelling

One spelling task was administered to all grade one children; thus there were two groups of 30 subjects. All statistical analyses were submitted to a two-by-two analysis of variance with language as the between-subject factor and syllable-structure (CCVC versus CVCC) as the within-subject repeated measure. The dependent variables were: (1) the overall phonetically acceptable spellings, (2) phonetically acceptable spellings in word-initial consonants, (3) phonetically acceptable spellings in word-final consonants.

Overall spelling results

The dependent measure was the number of phonetically acceptable spellings of eight CCVC nonwords and eight CVCC nonwords. The two-way analysis of variance yielded a main effect of language, $\underline{F}(1,58) = 16.764$, $\underline{p} < .0001$, and a significant language by syllable-structure interaction, $F(1,58) = 8.668$, $p < .005$. The overall means and standard deviations are reported in Table 5.

Table 5

Nonword Spelling: Percent Correct of Phonetically Acceptable Spellings (Standard Deviations)

	Language of the Subjects	
Syllable Structure	English	Czech
CCVC	35.84	65.4
	(19.6)	(13.8)
CVCC	41.66	55.0
	(23.8)	(14.3)

Tukey tests were used to examine the interaction. The effect of syllable structure was significant ($p < .05$) for the Czech children but not for the English children. Czech children made fewer errors on CCVC items than on CVCC items. Moreover, Czech children made significantly fewer errors than their English peers on both CCVC ($p < .01$) and CVCC ($p < .01$) nonwords.

It should be noted that effects of syllable structure in this analysis does not describe cluster errors in particular. Rather they illustrate how well children spell CCVC words as opposed to CVCC words. Thus, further analyses revealed that the Czech children's syllable-structure effect seems mainly to be due to a greater number of accent omissions on vowels in CVCC words rather than to errors on the final cluster. The absence of a syllable structure effect in the English data may be explained by the high number of errors that the English children made on vowels in both strucutre types. The Czechs, on the other hand made very few vowel errors. Appendix D contains a summary table of all observed error types and their frequencies.

Comparison of complex versus singleton onsets

The dependent measure was the number of acceptable representations of the target onset. That is, onsets which contained two phonetically acceptable consonants in complex onsets, and, one phonetically acceptable consonant in singleton onsets. Representations of only one member of a digraph (in the case of digraph consonants) or the omission of a diacritic marker were accepted. The two factor analysis of variance produced main effects of language, $F(1,58) = 13.101$, $p < .001$, and syllable structure, $F(1,58) = 19.526$, $p < .0001$, as well as a significant language by syllable structure interaction of, $F(1,58) = 7.394$, $p < .01$ (see Table 6).

The Tukey HSD comparisons revealed a significant syllable structure effect in the English group ($p < .01$) but not in the Czech group. The between-group difference was significant for the CCVC items ($p < .01$) with the Czech group producing more acceptable spellings, but it did not reach significance on the CVCC items. Thus, as in the previous phonological awareness tasks, the Czech group found the complex onsets no more difficult than singleton onsets, whereas both groups did equally well on the singleton onsets.

Onset errors were further classified into several types of errors (Appendix D). However, an error of particular interest and frequency was the omission of one consonant in the onset cluster. Of the all the errors committed on cluster onsets by the Anglophone group, 83.8% were due to the omission of a consonant. In the Czech group 79.3% of all cluster errors were accounted for by consonant omissions. In every case, the omitted consonant was the second of the cluster. Very clearly then, Anglophones omit consonants in cluster onsets much more frequently than Czechs. However, when both groups commit errors in the spelling of cluster onsets, they are equally likely to make the mistake of omitting the second consonant (as opposed to writing an unacceptable consonant for example).

Table 6

Nonword Spelling: Percent of Phonetically Acceptable Spellings (Standard Deviations) of Cluster and Single Onsets

	Language of the Subjects	
Syllable Structure	English	Czech
CCVC	79.6	95.8
	(24.5)	(12.0)
CVCC	97.1	100
	(6.25)	(0)

Comparison of Clusters Versus Single Consonants in the Word-Final Position

The dependent measure was the number of phonetically acceptable representations of the target word-final cluster. The analysis of variance yielded main effects of language, $F(1,58) = 9.904$, $p < .01$, and syllable-structure, $F(1,58) = 19.337$, $p < .0001$, as well as a language by syllable-structure interaction, $F(1,58) = 9.176$, $p < .01$.

The Tukey HSD comparisons showed a significant syllable-structure effect for the Anglophones ($p < .01$), but not for the Czech children. The difference between the Czech and English groups on CVCC items was significant ($p < .01$), with the Czech group performing significantly better. The difference between the two groups' scores on the CCVC items did not differ significantly (see Table 7).

Table 7

Nonword Spelling. Percent Phonetically Acceptable Spellings (Standard Deviations) of Word-final Clusters and Single Consonants

	Language of the Subjects	
Syllable Structure	English	Czech
CVCC	77.1	93.75
	(23.3)	(11.3)
CCVC	92.9	97.5
	(14.6)	(11.6)

The final-cluster errors were further examined in order to determine the prevalence of consonant omissions. Of the total number of errors in word-final clusters, 94.8% in the English data and 93% in the Czech data were consonant omissions. However, the English children omitted consonants approximately four times more frequently than the Czech children. The two groups differed in the proportion of first to second consonant omissions. Although the Czech children omitted the first consonant of the cluster (M = 62%) more frequently than the second (M = 38%), this difference was not as dramatic as in the English children's spellings. Virtually all of the English children's omissions involved the first consonant (M = 93%) rather than the last (M = 7%) consonant.

The above analyses reveal that in general Czech beginning spellers are more advanced than English beginning spellers, at least on nonwords. Czech first graders have less difficulty spelling complex syllable structures, while their ability to deal with simple onsets and codas is on par with Anglophones. At the same time there is evidence that Czech and English children tend to make the same kinds of errors on the spelling of clusters. This suggests that developmental trends in the acquisition of spelling are quite similar but input (albeit from different sources) plays an important role in the level of ability achieved by Czech children by the age of seven. Furthermore, the same trends apparent in the verbal tasks continue to hold for the spelling task.

Simple correlations were carried out in order to examine the relationship between the phonological awareness levels and spelling ability. Only the data of the 18 children who had taken the native language forms in each language group were submitted to the analysis. The English results yielded a significant correlation of .40 ($p < .05$) between Deletion and Nonword Spelling. None of the other tasks correlated significantly. This was due to the children's near-ceiling performances on the Same-Different and Isolation tasks. For the same reason, none of the correlations in the Czech data reached significance.

Chapter V: Discussion and Conclusion

The primary aim of this study was to examine the effects of oral language input on the development of phonological awareness. Of specific interest was whether the differences in the frequency and variety of complex syllabic onsets between Czech and English affected native speakers' awareness of these units. Given the large differences in both frequency of occurrence and variety of cluster onsets in Czech, it was hypothesized that if oral language input does have an effect, Czech children should show higher levels of awareness than English children prior to reading instruction. A second objective of this study was to investigate whether between-language differences would be reflected across modalities; that is, if Czech and English children's awareness of specific phonological units would be manifested not only in oral tasks, but also in a written task of spelling.

Because the Same-Different and the Isolation tasks were given to both age groups and the Deletion and Nonword Spelling tasks were administered only to the first grade children, the results of the two former tasks will be discussed first with an emphasis on the performance of the kindergarten children. A discussion of first grade results on Deletion and Nonword Spelling will follow.

The Same-Different and Isolation Tasks

The Same-Different task did not show between-language differences but it did show an effect of grade and of syllable structure. Kindergarten children found the task more difficult than first grade children who performed near ceiling (M = 93.1%). All children found sound judgements about word initial phonemes more difficult when these were parts of onsets than when they were whole onsets. Unlike the subsequent tasks, however, no language differences were apparent. The results suggest that this task may have been too difficult for the kindergarten and too easy for the first grade children. Much higher scores were achieved by kindergarteners on a similar same-different measure used by Treiman and Zukowski (in press). Although Treiman and Zukowski used CVCC and CCVC structures as in this study, theirs were real words. The mean scores of their kindergarten subjects were 80% for CCVCs and 89% for CVCCs. The kindergarteners in this study achieved combined means of 58% for CCVCs and 62% for CVCCs. It may be that the nonword stimuli used in the present study depressed kindergarteners' performances. Other evidence suggests that same-different tasks are in general less reliable than other phonological awareness measures (Yopp, 1988). Therefore, it is not surprising that patterns of performance on this task were quite different form those obtained by Treiman and Zukowski (in press).

In contrast to the Same-Different task, the Isolation task showed both developmental and language effects. Kindergarteners performed less well on the task than first graders and they found complex onsets particularly difficult. Aggregating across languages, the first grade children performed near ceiling (M = 96%) and were not differentially affected by syllable structure. Aggregating across grades, however, a syllable structure-by-language interaction revealed that the Czech children found CCVs easier to manipulate than English children. That they were not simply better at isolating linguistic units in general is shown by the fact that both language groups performed comparably on singleton onsets.

Cross-test comparisons provided evidence that the Czech children's higher scores were not an artifact of the Czech test. English children who took the test in Czech performed similarly to the English children who took the test in English. More importantly, the Czech children showed greater sensitivity to complex onsets on both the Czech and English versions of the test. Both analyses yielded syllable structure effects but no effects of test version. English kindergarteners differed from English first graders on the CCV items but did not differ from them on CVC items. The Czech kindergarten children differed significantly from the first graders on both syllable types.

The results of the Isolation task indicate that oral language input does have an effect, quite a specific one, on children's phonemic awareness. This was demonstrated by the finding that both kindergarten and first grade Czech children outperformed their English-Canadian peers on CCVs but showed equal performances on CVCs. The superiority of Czech children's ability on this task can not be due to literacy factors. The differences are clearly apparent among kindergarten children as well as among the first graders, and all the kindergarten children were nonreaders.

The possibility that cognitive factors and/or general language knowledge may have been partly responsible for the differences can not be ruled out empirically because no relevant measures were obtained. However, research suggests that cognitive factors are not strongly implicated in phonological awareness (Bryant et al.,1990; Torneus 1984; Wagner, 1988). More importantly, there is no reason to suspect that the English kindergarteners differed from the Czech kindergarteners in terms of general cognitive development.

Part of this argument is based on the vast literature showing that schooling has a major impact on all aspects of cognitive development (see Ceci, 1990 for a review). In this study, all the children had attended an "educational institution" for at least eight months by the time of testing. Teacher interviews and Ministry of Education curricula (Bednářová, Vanek, & Kohlová, 1988) indicate that the objectives of the kindergarten programmes are very similar in both countries. The main focus is on affective, social, perceptual, and motor development; direct literacy and academic instruction is discouraged. It is true that many of the Czech children had already attended nursery school for up to three years, but many Anglophone Canadian children attend preschool programmes or day care centres prior to entering kindergarten. Furthermore, English-Canadian preschoolers have access to a much wider variety of educational programming on television (a very potent medium).

Thus, although prior school attendance was not controlled, there is nothing to suggest that it (and by extension cognitive development) was a serious intervening factor.

It is also unlikely that general language development had a causal effect. Some researchers (e.g. Bowey & Patel, 1988) suggest that phonological awareness may in fact emerge as a function of general language knowledge. Again, there is no reason to suspect that the English-speaking children in this study, who came from upper-middle class homes, were linguistically disadvantaged. That exposure to rich linguistic input would have differentiated the Czech and English children is quite improbable. A commonality of Czech and Anglophone culture is that both place a very high value on literacy. Children's literature, in particular, has a long and impressive tradition in both cultures. Reciting nursery rhymes and poems, listening to stories, and playing language games make up much of children's early language experiences in Canada as in Czechoslovakia.

Briefly, the most plausible account of the results obtained from kindergarteners on the Isolation task is that the Czech children's higher level of phonemic awareness is mainly due to a greater exposure to particular linguistic structures and the greater variety of speech sounds within these structures. The language by syllable structure interaction in the main analysis (native-language) further indicates that Czech children continue to hold this advantage into grade one.

The Deletion and Spelling Tasks

Whereas the first two tasks were more revealing of kindergarten children's abilities, the Deletion task provided greater insight into the abilities of first graders. Between-language effects were most dramatic on this task. Whereas the Anglophone group showed a 53% difference in their ability to delete whole onsets as opposed to the first phoneme of an onset, the Czech group showed a 3% (nonsignificant) difference. This discrepancy can not be due to a lack of understanding of the task on the part of English children because their performance on CVC items did not differ from that of the Czech children. An inspection of the English children's errors further confirmed that they understood the task; for the vast majority, children produced rimes as answers, that is, they were stripping the whole onset.

Cross-test analyses confirmed that the language group effects were not caused by inequalities in the Czech test. When the scores of English children taking the English test were compared to English children taking the Czech test, highly similar results were produced. The English children continued to show high error rates on complex onsets whether the stimuli were Czech (61%) or English (61%). The Czech group also demonstrated the same pattern of performance across test versions. Syllable structure did not affect their performance, and they performed similarly on the Czech and English tests.

Because these large differences occurred between first grade children, one might conclude as Cossu et al. (1988) did that experience with a transparent orthography has a tremendous impact on raising children's levels of phonological awareness. Although such experience certainly plays a significant role, it seems somewhat exaggerated to conclude that literacy alone was the driving factor behind the differences. Bruck and Treiman (1990) gave a highly similar task to third grade English children whose reading and spelling abilities were at a beginning grade four level according to WRAT-R tests (hence they were proficient readers). These children still showed very high error rates (50%) on cluster onsets and did not differ significantly from second graders whose error rate was 63%. The Czech children in this sample were two years younger and were performing near ceiling on comparable items. In view of the higher levels of awareness demonstrated by Czech kindergarteners and more so by the first grade children, the nature of oral language input seems to play a very important role in developing phonological awareness.

Similar patterns of results were found in the spelling test. On this task, the possibility of effects due to test version was ruled out because all children were given the same items. Only the pronunciation differed to some degree with Czech-like pronunciations being used for the Czech test and English-like pronunciations being used for the English test. An analysis of error rates on cluster versus single-phoneme onsets yielded the same pattern as was found on the Deletion task. English children made significantly more errors (18%) in spelling complex onsets than single-consonant onsets. Their Czech peers showed a 4% difference from one syllable type to the other. Whereas English children committed errors on onset consonant clusters 20% of the time, the Czech children erred only 4% of the time. Both groups made virtually no errors on singleton onsets.

It seems that in the case of cluster onsets, the difference between Czech and English children's performances reflected differing levels of phonological awareness rather than superior spelling ability on the part of the Czech children (although this too was the case), or an advantage of the one-to-one correspondences of a transparent orthography. The only units that were evaluated in the above analysis were onsets, hence consonants. In English, consonant graphemes are generally stable across spelling contexts; in the onset position they are as stable as they are in Czech. Digraphs should also not have put the English children at a disadvantage; as it is, where the English test words required digraphs, the Czech words required diacritic markers for the consonant representing the same sound (e.g. <u>š</u> → <u>sh</u>). Neither group of children was penalized for representing only one member of a digraph or for omitting diacritic markers. The results seem to directly reflect differences in the awareness of complex onsets of English and Czech children. Thus the Nonword Spelling and the Deletion tasks portrayed the same patterns. A significant correlation between Deletion and Nonword Spelling in the English children's data suggests that both tasks are measuring a common element. The absence of such a correlation in the Czech data was due to ceiling effects.

The spelling data provided other information about how phonological awareness and orthography may affect Czech and English beginning spellers. Because half of the stimuli contained word-final clusters, a secondary analysis was carried out to examine children's abilities to spell clusters versus single consonants at the ends of words. The results were strikingly similar to those obtained from the onset analysis. For both groups, more errors were committed on consonants in the word-final position than in the onsets. This finding is to be expected because all word-final consonants have the status of phonemes. The Anglophone group committed significantly more errors on final clusters than on single consonants whereas the Czech children's performances did not differ statistically. Thus, in both language groups, the proportion of errors between syllable-structure in the word-final position (CVCC versus CCVC) and in the word-initial position (CCVC versus CVCC) remained virtually identical. The Czech children, however, made significantly fewer errors overall than English children.

These results call the effect of frequency of input on phonological awareness into question. The frequency count of word-final clusters in the Pilot Study (Chapter II) showed word-final clusters to be much more frequent in English than in Czech, with a ratio of 8.6:1. Consequently, many of the word-final clusters in the test were unusual to the Czech children. Nonetheless, the Czechs did not suffer a handicap in spelling these clusters whereas the English children did. As was discussed above, the one-to-one correspondence between phonemes and graphemes should not be an important factor in consonant spellings.

It is suggested that a combination of two factors is at play. First, Czech children may have a generally better developed awareness of consonant phonemes because they are so frequent in the language, albeit in syllable-initial positions, and this awareness generalizes to other speech sounds in words. Second, because Czech children learn to read and write a transparent orthography, a task easier than learning an opaque orthography like English (Lukatela & Turvey, 1980; DeRenzi et al., 1985; Venezky, 1980), Czech children's general spelling skills are simply more advanced than those of their English peers. In other words, learning an orthography which presents few irregularities and exceptions at the phoneme-grapheme level may accelerate the rate at which the learner acquires and understands the *concept* that the writing system represents each audible sound with a symbol (note that even the Czech orthography has its own phonological "irregularities" but these are for the most part irrelevant to the beginner). Thus language input *and* the orthographic regularity raise children's awareness all the more and enable them to spell even highly unusual sound sequences with considerable accuracy.

The onset and word-final cluster errors were further examined in order to determine whether Czech and English children make the same kinds of errors. A frequent finding in English children's spellings of consonant clusters is the tendency to omit one of the constituent consonants. Typically this is the consonant closest to the vowel (Read, 1975; Treiman, 1985a; in press). Indeed, both groups omitted consonants. Omissions constituted 84% of the total number of errors committed on complex onsets among English children and 79% among Czech children. None of these omissions involved the first consonant. Although English children err on complex onsets more frequently than Czech children, the likelihood of the error being the omission of the second consonant is approximately equal. Neither group is likely to omit the first consonant.

On word-final clusters, omissions represented 95% and 93% of the English and Czech groups' errors respectively. A difference arose in the proportion of first versus second consonants that were omitted. Out of a total of 45 omissions, 42 involved the penultimate consonant in the English data. Czech children tended to omit the penultimate consonant (8 from a total of 13 omissions) as almost as frequently as the second. However, in view of the small number of omissions by the Czech children in general, this finding may reflect individual differences rather than a language-specific trend.

An overall evaluation of the spellings suggests that Czech children are generally more advanced spellers than English children. An analysis of overall error rates by language group and syllable structure revealed a main effect of language. The Czech children were significantly better spellers than the English children. Post hoc analyses indicated that when the spelling of the entire word is taken into consideration, English children did not find CCVC nonwords more difficult than CVCC nonwords. The Czech group's results did show significantly more errors on CVCC nonwords. A qualitative examination of the errors, however, revealed that this effect was mainly due to more accent omissions on vowels in the CVCC words. The difference was not due to greater difficulty in representing the segmental or phonemic structure of these CVCC nonwords.

A large difference between the spellings of Czech and English beginners was in the representation of vowels. It is well documented that for English children, vowel spellings are the cause of most of their errors (Ehri, 1984; Marcel, 1980; Read, 1975; Treiman, in press). This is not surprising because vowels are the most variable segments in English spelling. For the child who has a rather phonetic representation of oral language, the morphophonological rules governing the behaviour of vowels in both spoken and written language are of little help. The instability of graphemic representations of the same sounds by different vowel graphemes and of the same vowel graphemes representing several sounds must be very confusing for the beginner.

Conversely, the regularity of Czech vowel spellings is likely to be a facilitator not only in the spelling of vowels but also in grasping the general notions about spelling. Learning that "what you hear is what you write" surely makes the acquisition of literacy skills quite straightforward. This is not to suggest that Czech orthography is purely transparent, for it is not. Some historical, morphological and phonological characteristics are retained in the spelling and are not reflected in pronunciation, although they affect consonants, not vowels. In comparison to English, however, these discrepancies are minimal.

Inaccurate vowel spellings may mainly reflect the deleterious effect of English orthography on children's early attempts to use the written language. However, there is also evidence suggesting that the English children are at a more primitive stage of spelling development than the Czech children. Gentry (1982) proposed five such stages: the precommunicative stage; the semiphonetic stage, the phonetic stage, the transitional stage, and the correct stage. Many, although not all, English first grade spellings still show characteristics of the semiphonetic and phonetic stage. The main indicator is that children could spell singleton onsets very well but had considerable difficulty with phonemes in general. For example not infrequent were vowel omissions, insertions of letters which are not phonetically or orthographically plausible, and, substitutions of target letters by phonetically and orthographically implausible letters (see Appendix D for a breakdown of observed error types and frequencies). These errors are typical of preschoolers (Read, 1975) and aphasic patients (Marcel, 1980).

Of course Gentry's model can only be used very generally to describe Czech children's spelling development because their orthography simply does not pose the same kinds of problems. Nonetheless, the precommunicative and semiphonetic stage is probably common to most learners of an alphabetic writing system. Yet the Czech children made semiphonetic errors very infrequently. In fact, many showed signs of transitional and correct stages in which knowledge of phonology and morphology are evident. Such knowledge was demonstrated by children who spelled some nonwords by analogy to real words in which the underlying and surface representations differ (e.g. word-final [t] represented by d in [sont] → sond; [plut] → plud). The most predominant error in their spellings was the omission of accents (56% of accents were omitted), followed by a tendency to omit diacritic markers (15%). These errors have much more to do with the technicalities of the orthography than with relating sounds to graphemes.

To summarize, the spelling data indicate that Anglophone children find complex onsets and word-final clusters more difficult than Czech children. Moreover, the qualitative analysis also revealed that the English children's spelling skills are generally much poorer. Certain types of errors (i.e., vowel confusions) seem to result from the complexity of the English orthography. Other errors, however, suggest that English first grade children still have rather immature notions about how speech is represented by written symbols, which may due to lower phonological awareness.

One factor which has to the present not been discussed is that of teaching methods. Among the English children, some came from classrooms where a Whole Language method was used while others were taught by more eclectic methods. In general, no English child was exposed to a pure phonics approach. The Czech children were all taught by a uniform methodology which is referred to as the "Analytico-Synthetic" method. As the name suggests, it is a phonics-based programme. Children are explicitly taught to segment and blend phonemes. These skills are not the only focus of reading instruction, and they are taught in the early stages of the year until children begin to read quasi-independently. Nevertheless, methodology quite possibly was an intervening factor in this study. Phonics-based approaches have been found to have significant effects on children's phonological awareness as well as on their literacy skills (Adams, 1990; Juel & Roper/Schneider, 1985; Perfetti, Beck, Bell, & Hughes, 1987).

However, two findings counter the possibility that instruction was the main factor influencing the Czech children's performance: 1)Czech preliterate kindergarteners show a higher awareness of phonemes, and, 2) English children who are proficient and independent readers still have considerable difficulty with clusters (Bruck & Treiman, 1990) which Czech children master before the end of the first grade. A way to control for instructional factors in a cross-linguistic (and cross-national) study such as this would be to compare Czech children to Anglophones learning with a phonics method. In view of the present popularity of the Whole Language approach in many English-speaking countries, however, such a control may be difficult to ensure.

Conclusion

The general findings reveal that oral language input plays an important role in raising children's phonological awareness. This is supported by the significant but specific differences in children's abilities to manipulate cluster onsets on phonological awareness tasks. Czech children demonstrate a greater ability to isolate the first phonemes in cluster onsets prior to learning to read and continue to show this advantage in relation to English children into the first grade on phoneme deletion ability. Furthermore, the children's spellings reflect between-language differences not only in the ability to represent consonant clusters, but also in general spelling ability. English children's spellings show signs of lower phonological awareness and of difficulties imposed by the English orthography.

These findings draw much the same picture as was described by Cossu et al. (1988) of Italian and American children. Although they used different tasks, the same early advantage in phonemic awareness was apparent among Italian children. In their study, the most dramatic differences also occurred in grade one with Italian children performing at ceiling on phoneme counting.

Cossu et al. (1988) suggest that at the root of these differences is a combination of a simpler syllabic structure in oral language input, a transparent orthography in written language input, and a simple vowel system in both types of input. All of these factors, they claim, play a role in sensitizing children to phonemic units. The results of the present study provide new evidence that indeed similar findings can be replicated with children acquiring another transparent orthography. However, Czech syllable structure is more complex than Italian. Both languages have fairly simple vowel systems and these remain stable in the written language. On the other hand, closed syllables are not infrequent in Czech (although complex codas are), but, the greatest complexity is at the level of onsets. Thus it is argued here that it may not merely be the simplicity of syllable structure but the frequency of occurrence of particular structures and the variety of phonemic segments that may be represented by those structures that may play an important role in sensitizing children to phonemes.

In closing, this study suggests that, in order to fully understand the nature of phonological awareness, research must be extended to cross-linguistic comparisons. To date very little attention has been paid to how language-specific factors may affect the development of this fundamental ability. The present findings demonstrate that specific linguistic characteristics and oral language input have significant effects on phonemic awareness and on emergent spelling skill.

References

Adams, M. (1990). Beginning to read: Thinking and learning about print. Cambridge, MA: MIT Press.

Backman, J., Bruck, M., Hébert, M., & Seidenberg, M. S. (1984). Acquisition and use of spelling-sound correspondences in reading. Journal of Experimental Child Psychology, 38, 114-133.

Ball, E. W., & Blachman, B. A. (1991). Does phoneme awareness training in kindergarten make a difference in early word recognition and developmental spelling? Reading Research Quarterly, 26, 49-66.

Baron, J., & Treiman, R. (1980). Use of orthography in reading and learning to read. In J. F. Kavanagh & R. L. Venezky (Eds.), Orthography, reading, and dyslexia (pp. 171-189). Baltimore, MD: University Park Press.

Bialystok, E. (1988). Aspects of linguistic awareness in reading comprehension. Applied Psycholinguistics, 9, 123-139.

Bialystok, E. (1990). The role of attentional control in children's solutions to metalinguistic problems. Unpublished manuscript, York University, Toronto.

Biemiller, A. (1977-1978). Relationships between oral reading rates for letters, words, and simple text in the development of reading achievement. Reading Research Quarterly, 13, 223-253.

Bowey, J. A., & Patel, R. K. (1988). Metalinguistic ability and early reading achievement. Applied Psycholinguistics, 9, 367-383.

Bowey, J. A., & Tunmer, W. E. (1984). Word awareness in children. In W. E. Tunmer, C. Pratt, & M. L. Herriman (Eds.), Metalinguistic awareness in children (pp. 73-127). New York: Springer-Verlag.

Bradley, L. (1988). Rhyme recognition and reading and spelling in young children. In R. L. Masland & M. R. Masland (Eds.), Pre-school prevention of reading failure (pp.143-162). Maryland: York Press.

Bradley, L., & Bryant, P. E. (1978). Difficulties in auditory organisation as a possible cause of reading backwardness. Nature, 271, 746-747.

Bradley, L., & Bryant, P E. (1983). Categorising sounds and learning to read - a causal connection. Nature, 301, 419-521.

Bryant, P. E., & Bradley, L. (1985). Children's reading problems. Oxford: Blackwell.

Bryant, P. E., MacLean, M., Bradley, L., & Crossland, J. (1990). Rhyme and alliteration, phoneme detection, and learning to read. Developmental Psychology, 26, 429-438.

Bruce, D. J. (1964). The analysis of word sounds by young children. British Journal of Educational Psychology, 34, 158-170.

Bruck, M., & Treiman, R. (1990). Phonological awareness and spelling in normal children and dyslexics: The case of initial consonant clusters. Journal of Experimental Child Psychology, 50, 156-178.

Calfee, R. C. (1977). Assessment of individual reading skills: Basic research and practical applications. In A. S. Reber & D. L. Scarborough (Eds.), Toward a psychology of reading. New York: Lawrence Erlbaum Associates Inc.

Calfee, R. C., Lindamood, P., & Lindamood, C. (1973). Acoustic-phonetic skills and reading - kindergarten through twelfth grade. Journal of Educational Psychology, 64, 293-298.

Ceci, S. J. (1990). On intelligence... more or less. Englewood Cliffs, NJ: Prentice Hall.

Chukovsky, K. (1963). From two to five. Berkeley:

Content, A. (in press). Segmental analysis abilities constitute a powerful accelerator of reading acquisition. Mind and Language.

Content, A., Kolinsky, R., Morais, J., & Bertelson, P. (1986). Phonetic segmentation in prereaders: Effect of corrective information. Journal of Experimental Child Psychology, 42, 49-72.

Cossu, G., Shankweiler, D., Liberman, I. Y., &Tola, G. (1988). Awareness of phonological segments and reading ability in Italian children. Applied Psycholinguistics, 9, 1-16.

Cutler, A., Butterfield, S., & Williams, J. N. (1987). The perceptual integrity of syllabic onsets. Journal of Memory and Language, 26, 406-418.

Dewey, G. (1923). Relative frequency of English speech sounds. Cambridge, MA: Harvard University Press.

Donaldson, M. (1978). Children's minds. Glasgow: Collins.

Dowker, A. (1989). Rhyme and alliteration in poems elicited from young children. Journal of Child Language, 16, 181-202.

Ehri, L. C. (1979). Linguistic insight: Threshold of reading acquisition. In T. G. Waller & G. E. MacKinnon (Eds.), Reading research: Advances in theory and practice (Vol. 1, pp. 63-114). New York: Academic Press.

Ehri, L. C. (1984). How orthography alters spoken language competencies in children learning to read and spell. In J. Downing & R. Valtin (Eds.), Language awareness and learning to read. New York: Springer-Verlag.

Ehri, L. C., & Wilce, L. S. (1980). The influence of orthography on readers' conceptualization of the phonemic structure of words. Applied Psycholinguistics, 1, 371-385.

Ehri, L. C., & Wilce, L. S. (1987). Does learning to spell help beginners learn to read words? Reading Research Quarterly, 22, 47-65.

Elkonin, D. B. (1971). Development of speech. In A. V. Zaporozhets and D. B. Elkonin (Eds.), The Psychology of Preschool Children. Cambridge, MA: MIT Press.

Fox, B. & Routh, D. K. (1975). Analysing spoken language into words, syllables and phonemes: A developmental study. Journal of Psycholinguistic Research, 4, 331-342.

Fox, B. & Routh, D. K. (1976). Phonemic analysis and synthesis as word-attack skills. Journal of Educational Psychology, 68, 70-74.

Fox, B. & Routh, D. K. (1980). Phonemic analysis and severe reading disability in children. Journal of Psycholinguistic Research, 9, 115-120.

Fox, B. & Routh, D. K. (1984). Phonemic analysis and synthesis as word-attack skills: Revisited. Journal of Educational Psychology, 76, 1059-1064.

Freebody, P. & Byrne, B. (1988). Word-reading strategies in elementary school children: Relations to comprehension, reading time, and phonemic awareness. Reading Research Quarterly, 23, 441-453.

Fromkin, V. A. (1971). The non-anomalous nature of anomalous utterances. Language, 47, 27-52.

Fudge, E. C. (1969). Syllables. Journal of Linguistics, 5, 193-320.

Gentry, J. R. (1982). An analysis of developmental spelling in GNYS AT WRK. The Reading Teacher, 36, 192-200.

Gleitman, L. R., Gleitman, H., & Shipley, E. F. (1972). The emergence of the child as grammarian. Cognition, 1, 137-164.

Goswami, U. (1986). Children's use of analogy in learning to read: A developmental study. Journal of Experimental Child Psychology, 42, 73-83.

Goswami, U. (1988). Orthographic analogies and reading development. Quarterly Journal of Experimental Psychology, 40A, 239-268.

Goswami, U., & Bryant, P. (1990). Phonological skills and learning to read. Hillsdale, NJ: Erlbaum.

Halle, M., & Vergnaud, J-R. (1980). Three dimensional phonology. Journal of Linguistic Research, 1, 83-105.

Hohn, W. E., & Ehri, L. C. (1983). Do alphabet letters help prereaders acquire phonemic segmentation skill? Journal of Educational Psychology, 75, 752-762.

Jelínek, J., Bečka, J., & Tesitelová. (1961). Frekvence slov, slovních druhu a traru v českém jazyce [The frequency of words, word types and forms in the Czech language]. Praha: Státní Pedagogické Nakladatelství.

Juel, C., & Roper/Schneider, D. (1985). The influence of basal readers on first grade reading. Reading Research Quarterly, 20, 134-152.

Kučera, H. (1961). The phonology of Czech. The Hague: Mouton & Co.

Kučera, H., & Francis, W. N. (1967). Computational analysis of present-day American English. Providence, RI: Brown University Press.

Ladefoged, P. (1982). A course in phonetics (2nd ed.). San Diego: Harcourt, Brace, Jovanovich.

Liberman, I. Y., Liberman, A. M., Mattingly, I., & Shankweiler, D. (1980). Orthography and the beginning reader. In In J. F. Kavanagh & R. L. Venezky (Eds.), Orthography, reading, and dyslexia (pp. 137-153).

Liberman, I. Y., Shankweiler, D., Fischer, F. W., & Carter, B. (1974). Explicit syllable and phoneme segmentation in the young child. Journal of Experimental Child Psychology, 18, 201-212.

Liberman, I. Y., Shankweiler, D., Liberman, A.,M., Fowler, C., & Fischer, F., W. (1977). Phonetic segmentation and recoding in the beginning reader. In A. S. Reber & D. L. Scarborough (Eds.), Toward a Psychology of Reading. Hillsdale, NJ: Lawrence, Erlbaum.Associates.

Lindgren, S., D., DeRenzi, E., & Richman, L. C. (1985). Cross-national comparisons of developmental dyslexia in Italy and the United States. Child Development, 56, 1404-1417.

Lukatela, G., &Turvey, M. T. (1980). Some experiments on the Roman and Cyrillic alphabets of Serbo-Croatian. In J. F. Kavanagh & R. L. Venezky (Eds.), Orthography, reading, and dyslexia (pp. 227-247). Baltimore, MD: University Park Press.

Lundberg, I., Frost, J., & Petersen, O. (1988). Effects of an extensive program for stimulating phonological awareness in preschool children. Reading Research Quarterly, 23, 263-284.

Lundberg, I., Olofsson, A., &Wall, S. (1980). Reading and spelling skills in the first school years predicted from phonemic awareness skills in kindergarten. Scandinavian Journal of Psychology, 21, 159-173.

MacKay, D. G. (1972). The structure of words and syllables: Evidence from errors is speech. Cognitive psychology, 3, 210-227.

MacLean, M., Bryant, P. E., & Bradley, L. (1987). Rhymes, nursery rhymes, and reading ability in early childhood. Merrill-Palmer Quarterly, 33, 255-281.

Mann, V. A. (1984). Longitudinal prediction and prevention of early reading difficulty. Annals of Dyslexia, 34, 117-136.

Mann, V. A., & Liberman, I. Y. (1984). Phonological awareness and verbal short-term memory. Journal of Reading Disabilities, 17, 592-599.

Mann, V. A. (1986). Phonological awareness: The role of reading experience. Cognition, 24, 65-92.

Marcel, T. (1980). Phonological awareness and phonological representation: Investigation of a specific spelling problem. In U. Frith (Ed.), Cognitive processes in spelling (pp.373-403). London: Academic Press.

McCormick, C., & Samuels, S. J. (1979). Word recognition by second graders: The unit of perception and interrelationships among accuracy, latency, and comprehension. Journal of Reading Behaviour, 11, 2, 107-118.

Morais, J., Alegria, J., & Content, A. (1987). The relationship between segmental analysis and alphabetic literacy: An interactive view. Cahiers de Psychologie Cognitive, 7, 415-438.

Morais, J., Cary, L., Alegria, J., & Bertelson, P. (1979). Does awareness of speech as a sequence of phones arise spontaneously? Cognition, 7, 323-331.

Morais, J., Bertelson, P., Cary, L., & Alegria, J. (1986). Literacy training and speech segmentation. Cognition, 24, 45-64.

Morton, J., & Sasanuma, S. (1984). Lexical access in Japanese. In L. Henderson (Ed.), Orthographies and reading. London: Erlbaum.

Nagy, W. E., & Anderson, R. C. (1982). The number of words in printed school English (Tech. Rep. No. 253). Champaign, IL: University of Illinois at Urbana-Champaign.

Pace, A. J., & Golinkoff, R. M. (1976). Relationship between word difficulty and access of single word meaning by skilled and less skilled readers. Journal of Educational Psychology, 68, 6, 670-767.

Perfetti, C. A., Beck, I., Bell, L. C., & Hughes, C. (1987). Phonemic knowledge and learning to read are reciprocal: A longitudinal study of first grade children. Merrill-Palmer Quarterly, 33, 283-319.

Perfetti, C. A., & Hogaboam, T. (1975). Relationship between single word decoding and reading comprehension skill. Journal of Educational Psychology, 67, 461-469.

Perin, D. (1983). Phonemic segmentation and spelling. British Journal of Psychology, 74, 129-144.

Read, C. (1975). Children's categorizations of speech sounds in English. NCTE Research Report No. 17. Urbana, IL: National Council of Teachers of English.

Read, C., Zhang, Y-F., Nie, H-Y., & Ding, B-Q. (1986). The ability to manipulate speech sounds depends on knowing alphabetic writing. Cognition, 24, 31-44.

Rosner, J. (1974). Auditory analysis training with prereaders. Reading Teacher, 27, 379-384.

Share, D. L., Jorm, A. F., Maclean, R., & Matthews, R. (1984). Sources of Individual differences in reading acquisition. Journal of Educational Psychology, 76, 1309-1324.

Skaličková, A. (1974). Srovnávací fonetika angličtiny a češtiny [Comparative phonetics of English and Czech]. Praha: Academia.

Stanovich, K. E. (1986). Matthew effects in reading: Some consequences of individual differences in acquisition of literacy. Reading Research Quarterly, 21, 360-407.

Stanovich, K. E., Cunningham, A. E., & Cramer, B (1984). Assessing phonological awareness in kindergarten children: Issues of task comparability. Journal of Experimental Child Psychology, 38, 175-190.

Stanovich, K. E. (1991). Discrepancy definitions of reading disability: Has intelligence led us astray? Reading Research Quarterly, 26, 7-29.

Studdert-Kennedy, M. (1975). From continuous signal to discrete message: Syllable to phoneme. In J. F. Kavanagh & J. E. Cutting (Eds.), The Role of speech in language. Cambridge, MA: MIT Press.

Tornéus, M. (1984). Phonological awareness and reading: A chicken and egg problem? Journal of Educational Psychology, 76, 1346-1358.

Treiman, R. (1985a). Onsets and rimes as units of spoken syllables: Evidence from children. Journal of Experimental Child Psychology, 39, 161-181.

Treiman, R. (1985b). Phonemic awareness and spelling: Children's judgments do not always agree with adults'. Journal of Experimental Child Psychology, 39, 182-201.

Treiman, R., & Baron, J. (1981). Segmental analysis ability: Development and relation to reading ability. In G. E. MacKinnon & T. G. Waller (Eds.), Reading research: Advances in theory and practice (Vol. 3, pp. 159-198). New York: Academic Press.

Treiman, R., Salasoo, A., Slowiaczek, L. M., & Pisoni, D. B. (1982). Effects of syllable structure on adults' phoneme monitoring performance. Progress Report No. 8, Indiana University, Speech Research Laboratory.

Treiman, R., & Zukowski, A. (in Press). Levels of phonological awareness. In S. Brady & D. Shankweiler (Eds.), Phonological processes in literacy . Hillsdale, NJ: Erlbaum.

Treiman, R. (in press). Beginning to spell: A study of first grade children.

Tunmer, W. E., & Fletcher, C. M. (1981). The relationship between conceptual tempo, phonological awareness, and word recognition in beginning readers. Journal of Reading Behavior, 13, 173-186.

Tunmer, W. E., Herriman, M. L., & Nesdale, A. R. (1988). Metalinguistic abilities and beginning reading. Reading Research Quarterly, 23, 134-158.

Tunmer, W. E., & Nesdale, A. R. (1985). Phonemic segmentation skill and beginning reading. Journal of Educational Psychology, 77, 417-427.

Tunmer, W. E., Pratt, C., & Herriman, M. L. (1984). Metalinguistic awareness in children. New York: Springer Verlag.

Bednářová, J., Vanek, P., & Kohlová, J. (1988). Předškolní vychova v CSSR [Preschool education in Czechoslovakia]. Praha: Ustav školskych informací.

Venezky, R. L. (1980). From Webster to Rice to Roosevelt: The formative years for spelling instruction and spelling reform in the U.S.A. In U. Frith (Ed.), Cognitive processes in spelling (pp.9-30). London: Academic Press.

Wagner, R. K, & Torgesen, J. K. (1987). The nature of phonological processing and its causal role in the acquisition of reading. Psychological Bulletin, 101, 192-212.

Wagner, R., K. (1988). Causal relations between the development of phonological processing abilities and the acquisition of reading skills: A meta-analysis. Merrill-Palmer Quarterly, 34, 261-279.

Williams, J. P. (1980). Teaching decoding with an emphasis on phoneme analysis and phoneme blending. Journal of Educational Psychology, 72, 1-15.

Yopp, H. K. (1988). The validity and reliability of phonemic awareness tests. Reading Research Quarterly, 23, 159-177.

APPENDICES

Appendix A

Percent frequencies of mono-syllabic and multi-syllabic words in Czech and English adult and children's texts. The total number of words for each language and age group was 400.

	Word Size				
Text type	1 syllable	2 syllable	3 syllable	4 syllable	5 & 6 syllable
Czech Adult	31.73	29.95	23.60	12.44	2.31
Czech Child	37.47	36.43	19.12	6.2	0.78
English Adult	67.76	23.68	5.79	0.25	0.00
English Child	79.9	17.75	2.35	0.00	0.00

Appendix B

Word-Initial Clusters in the Czech Language.

	Cluster	Tokens	Types	Cum. Freq.
1)	[pr]	729	379	40,738
2)	[př]	953	505	36,280
3)	[st]	272	133	17,602
4)	[gd]	27	5	13,818
5)	[sv]	102	51	12,193
6)	[kt]	7	2	11,915
7)	[vj]	77	30	11,354
8)	[fš]	39	28	11,319
9)	[sl]	199	75	9,518
10)	[hl]	102	33	8,069
11)	[kr]	167	78	7,651
12)	[sp]	258	93	6,102
13)	[str]	97	44	5,959
14)	[pl]	181	80	5,558
15)	[vl]	77	39	5,053
16)	[sk]	94	53	4,519
17)	[zn]	72	31	4,448
18)	[dv]	50	27	4,343
19)	[hr]	91	39	4,219
20)	[tv]	32	11	4,144
21)	[dr]	99	47	3,994
22)	[tř]	53	28	3,883
23)	[svj]	50	18	3,843
24)	[kl]	146	71	3,629
25)	[ml]	45	17	3,444
26)	[zd]	57	22	3,380
27)	[čl]	15	4	3,283
28)	[mɲ]	52	13	3,277
29)	[sm]	85	39	3,125
30)	[tr]	148	84	3,116
31)	[sn]	29	14	2,965
32)	[zv]	78	31	2,752
33)	[br]	76	45	2,454
34)	[dn]	6	3	2,348
35)	[zb]	60	28	2,202
36)	[χv]	16	6	2,144
37)	[vr]	57	29	2,125
38)	[mn]	25	11	2,077
39)	[šk]	40	16	2,053
40)	[vžd]	3	2	2,039
41)	[smɲ]	25	11	1,986
42)	[zl]	68	28	1,968
43)	[spr]	55	27	1,967

44)	[vz]	26	14	1,898
45)	[hn]	15	7	1,849
46)	[χl]	49	18	1,745
47)	[dl]	21	9	1,720
48)	[kř]	67	28	1,671
49)	[stř]	79	39	1,615
50)	[sχ]	24	23	1,594
51)	[ps]	34	13	1,580
52)	[dř]	21	10	1,456
53)	[kɲ]	20	7	1,369
54)	[pj]	43	19	1,364
55)	[zr]	47	22	1,341
56)	[skl]	57	19	1,340
57)	[zm]	60	33	1,246
58)	[vzd]	25	9	1,228
59)	[šť]	44	20	1,148
60)	[bl]	84	25	1,097
61)	[fst]	22	8	1,076
62)	[čt]	43	20	1,072
63)	[zvl]	6	2	1,072
64)	[jm]	10	2	1,009
65)	[sť]	40	17	987
66)	f[sp]	13	5	956
67)	[zj]	25	10	925
68)	[tl]	30	12	912
69)	[šp]	42	20	906
70)	[sɲ]	32	13	829
71)	[zř]	26	11	827
72)	[vɲ]	23	8	806
73)	[zdr]	18	7	777
74)	[pt]	9	2	758
75)	[zmɲ]	7	4	745
76)	[mr]	35	12	707
77)	[sc]	8	5	702
78)	[skr]	35	15	689
79)	[fr]	22	14	676
80)	[kv]	47	21	666
81)	[vzɲ]	12	4	665
82)	[spj]	17	7	649
83)	[tm]	9	5	603
84)	[hř]	27	13	596
85)	[bř]	25	14	595
86)	[hm]	9	3	562
87)	[zvj]	21	7	507
88)	[χr]	35	18	498
89)	[fč]	8	4	491

90)	[zh]	51	27	487
91)	[lz]	1	1	479
92)	[zɲ]	8	2	458
93)	[hɲ]	16	8	406
94)	[skř]	19	9	387
95)	[vzr]	12	2	378
96)	[mzd]	2	1	362
97)	[kvj]	11	4	360
98)	[dc]	5	1	336
99)	[zdv]	11	6	334
100)	[sr]	17	7	329
101)	[zbr]	12	5	317
102)	[sχr]	8	4	295
103)	[lh]	8	4	293
104)	[sj]	14	4	287
105)	[vzn]	8	2	276
106)	[hvj]	7	1	272
107)	[šl]	18	8	263
108)	[km]	11	6	260
109)	[vh]	9	4	254
110)	[spl]	25	11	252
111)	[ft]	6	5	249
112)	[šv]	23	11	238
113)	[fsk]	6	4	238
114)	[zď]	18	8	238
115)	[fstř]	9	4	220
116)	[cv]	13	4	195
117)	[vzď]	10	1	193
118)	[zbl]	13	7	191
119)	[sχl]	6	3	187
120)	[žl]	10	5	180
121)	[fť]	11	4	179
122)	[vzb]	8	2	179
123)	[gr]	19	15	176
124)	[ďb]	2	1	175
125)	[χvj]	3	1	169
126)	[vd]	15	4	162
127)	[stv]	10	5	158
128)	[vzh]	1	1	155
129)	[sml]	7	2	154
130)	[tk]	7	2	150
131)	[vzhl]	4	2	150
132)	[hřb]	3	2	137
133)	[bd]	6	1	135
134)	[vn]	10	4	134
135)	[vď]	5	1	131
136)	[fp]	8	4	128

137)	[fs]	8	5	126
138)	[skvj]	4	1	125
139)	[zbj]	17	6	122
140)	[sχv]	5	2	122
141)	[cť]	6	3	118
142)	[fχ]	2	1	111
143)	[vzl]	10	2	111
144)	[fpř]	2	1	109
145)	[fl]	18	13	109
146)	[vř]	11	9	101
147)	[spř]	11	9	100
148)	[rv]	2	1	99
149)	[šr]	10	7	98
150)	[kn]	5	4	94
151)	[fkl]	5	2	88
152)	[skv]	9	5	87
153)	[χm]	8	3	82
154)	[fpr]	4	3	82
155)	[žh]	5	2	82
156)	[sť]	9	5	81
157)	[zhr]	5	4	81
158)	[sč]	11	7	76
159)	[zvr]	8	3	76
160)	[mř]	6	3	71
161)	[mst]	4	1	70
162)	[štv]	5	1	69
163)	[hv]	5	2	67
164)	[řv]	3	1	67
165)	[pš]	3	2	65
166)	[svl]	4	1	61
167)	[št]	8	6	59
168)	[šm]	9	4	58
169)	[zhl]	7	5	57
170)	[[žr]	4	2	57
171)	[žv]	8	4	54
172)	[škr]	6	3	54
173)	[žn]	3	1	54
174)	[lž]	3	2	52
175)	[sf]	4	4	50
176)	[tkv]	2	1	50
177)	[hřm]	6	1	49
178)	[mdl]	3	1	48
179)	[ct]	3	1	46
180)	[mž]	7	2	46

181)	[džb]	3	1	43
182)	[cl]	4	3	41
183)	[fspl]	3	2	41
184)	[tř[illegible]	4	1	40
185)	[[illegible]kř]	4	2	40
186)	[fk]	2	1	39
187)	[jh]	1	1	38
188)	[čp]	4	2	34
189)	[lpj]	2	1	32
190)	[mš]	1	1	32
191)	[fkr]	2	2	29
192)	[jmj]	1	1	29
193)	[fc]	2	2	28
194)	[jd]	1	1	28
195)	[stm]	5	3	28
196)	[dm]	2	2	25
197)	[šɲ]	3	2	25
198)	[tχ]	3	2	25
199)	[smr]	4	2	24
200)	[vm]	4	3	23
201)	[bz]	2	1	23
202)	[pn]	4	3	23
203)	[rd]	3	1	23
204)	[škv]	4	3	23
205)	[fspř]	2	1	21
206)	[[illegible]bj]	1	1	20
207)	[svr]	4	2	20
208)	[fsχ]	2	2	19
209)	[vž]	3	1	18
210)	[zdř]	2	2	18
211)	[fčl]	2	1	17
212)	[špr]	3	1	17
213)	[pst]	2	2	16
214)	[scv]	3	1	16
215)	[sχɲ]	2	1	16
216)	[třm]	2	2	15
217)	[rn]	2	1	15
218)	[cp]	1	1	14
219	[ln]	1	1	14
220)	[lv]	2	1	14
221)	[žm]	3	1	14
222)	[kšt]	1	1	13
223)	[lk]	1	1	13
224)	[rč]	1	1	13
225)	[žď]	3	3	13

226)	[fpl]	2	2	12
227)	[čn]	1	1	12
228)	[štk]	1	1	12
229)	[zdl]	2	1	12
230)	[kři]	2	1	11
231)	[lsť]	2	1	11
232)	[fspr]	2	1	11
233)	[vb]	2	2	10
234)	[čm]	3	3	10
235)	[gb]	1	1	10
236)	[sχn]	2	1	9
237)	[cr]	1	1	8
238)	[gl]	2	1	8
239)	[χɲ]	2	1	8
240)	[špl]	2	2	8
241)	[sš]	2	2	8
242)	[mh]	1	1	7
243)	[tkn]	1	1	7
244)	[třť]	1	1	6
245)	[lɲ]	1	1	6
246)	[ftl]	2	1	6
247)	[pšt]	1	1	5
248)	[rz]	1	1	5
249)	[vzm]	1	1	5
250)	[zhř]	1	1	5
251)	[tkl]	1	1	4
252)	[vhl]	1	1	3
253)	[gn]	1	1	3
254)	[kš]	1	1	3
255)	[rt]	1	1	3
256)	[rž]	1	1	3
257)	[fskl]	1	1	3
258)	[fskv]	1	1	3

Appendix B (continued)

Word-initial Clusters in the English Language.

	Cluster	Tokens	Types	Cum. Freq.
1)	[pr]	804	341	11,661
2)	[st]	600	289	9,385
3)	[fr]	290	142	7,372
4)	[tr]	477	219	4,938
5)	[gr]	398	197	4,483
6)	[pl]	213	100	3,430
7)	[br]	424	243	3,404
8)	[sk]	337	161	3,381
9)	[kl]	316	153	3,301
10)	[sp]	295	137	3,118
11)	[kr]	421	209	2,778
12)	[str]	188	93	2,473
13)	[θr]	73	32	2,257
14)	[dr]	215	75	2,227
15)	[bl]	242	116	1,561
16)	[fl]	271	117	1,545
17)	[sl]	169	72	1,235
18)	[sm]	77	45	1,205
19)	[sw]	131	57	796
20)	[gl]	142	67	720
21)	[spr]	39	21	398
22)	[sn]	94	49	367
23)	[tw]	38	17	366
24)	[skr]	67	30	350
25)	[šr]	40	20	115
26)	[spl]	28	12	101
27)	[dw]	18	9	66
28)	[sf]	6	3	37
29)	[šn]	5	3	15
30)	[thw]	4	2	9
31)	[šl]	5	5	7
32)	[kw]	4	4	6
33)	[šm]	4	4	4
34)	[skl]	2	1	3
35)	[ks]	1	1	1

Appendix C

English Same-Different Task.

Demonstration Items: krin-klav, flidge-freet, krav-flidge.

Practise Items: brool-blad, simp-salsh, krov-spood, tard-poosk, molf-misk.

Test Items

Yes pairs	No pairs
CCVC	**CCVC**
flas-freb	trab-snok
throop-thwach	droog-klab
plit-prak	glek-stin
swek-slod	bril-twop
skoor-spall	smab-dwesh
blek-brosh	klop-sken
dweg-droos	thrik-flom
staz-smeed	spoodge-prot
gloot-grof	swog-brech
twap-troog	thwid-shraum
CVCC	**CVCC**
fils-farb	darp-mont
tholt-thabs	gelm-teefs
palt-poork	koolb-sanch
sark-silf	hort-jenk
semp-soold	lomp-wust
goolt-gorf	rast-nelk
bilk-boorsh	moosk-voshp
sont-salp	punce-hilm
dosk-darm	foorb-jaft
temk-tobs	keert-lopse

Appendix C (continued)

Czech Same-Different Task.

Demonstration Items: krin-klav, flidž-frít, krav-flidž.

Practise Items: brúl-bláď, simp-salsh, krov-spúd, tard-púsk, molf-misk.

Test Items:

Yes pairs	No pairs
CCVC	**CCVC**
sjup-sleš	broch-pluv
plit-prák	hlaj-šrouk
tříp-trom	krág-chlud
hlek-hrof	spáž-prot
stáz-smíd	glek-styn
skúr-spál	drúg-kláb
blum-bróš	bril-třez
chlák-chvip	klop-sken
vlaš-vreb	trag-snok
dlof-drús	smáb-ptóš
CVCC	**CVCC**
chalc-chont	panc-hilm
sónt-salp	fúrb-jaft
válš-verk	darp-mónt
pilt-púrk	kerm-lóps
helk-horf	gelk-tífs
semp-súld	músk-vóšp
dump-dolm	lomp-vust
temk-tolf	rást-nelk
sajp-selm	kúlb-sanč
belm-bošt	hast-jenk

Appendix C (continued)

Isolation

Demonstration Items: zat, loim, stau.
English Practise Items: marr, zaff, stog, kreen.
Czech Practise Items: fál, bóf, šme, čpá.

Test Items:

English Isolation.	**Czech Isolation.**
CCV	**CCV**
slau	sla
fla	mla
troi	tra
klee	klí
ploy	plau
broi	bró
shrigh	chrá
drau	dru
thray	vrí
gligh	hló
CVC	**CVC**
poil	pál
shire	chár
daur	dur
saul	sal
their	vir
guile	hói
fal	mal
boir	bor
toir	tar
keel	kíl

Appendix C (continued)

Deletion

Demonstration Items:	mab, bim, shram, glaup
English Practise Items:	sug, toop, spou, krah
Czech Practise Items:	súg, túp, spou, krá

Test Items:

English Deletion.	Czech Deletion.
CCV	**CCV**
klee	klá
bree	bro
sta	stú
fley	vlé
twa	čle
skoo	ska
proo	prú
thra	chvá
CVC	**CVC**
sool	sal
fip	vip
thom	chog
tuke	čan
seb	som
pesh	pež
baf	buf
koob	kim

Appendix C (continued)

Nonword Spelling Test.

English spelling	Czech spelling
CCVC	**CCVC**
smeed	smíd
flas	flas
stin	styn
ploot	plút
skoom	skúm
shrook	šrúk
sneg	sneg
brel	brel
CVCC	**CVCC**
shork	šork
bart	bárt
palt	pólt
carm	kárm
soold	suld
sont	sont
semp	semp
fils	fils

Appendix D

Nonword Spelling task: Error categories and percent of ocurrence in each language and syllable type.

	English		Czech	
Type of Error	CCVC	CVCC	CCVC	CVCC
Omit C in cluster	15%	19.16%	0.83%	5.42%
Substitute C in cluster	2.08%	2.08%	0.83%	0.42%
Insert C in cluster	1.25	2.08	0.00	0.42
Insert V in cluster	0.83	0.42	2.08	0.42
Omit V (head)	7.5	14.6	0.83	0.00
Substitute V in head	9.58	16.25	0.42	0.83
Insert V in head	6.25	2.92	0.42	0.42
Omit C singleton	0.00	0.00	1.25	0.00
Substitute C singleton	1.25	1.66	0.42	0.00
Neutralization/ Assimilation	2.08	0.00	5.41	9.58
Omit diacritic/ digraph member	33.33	33.33	20.00	10.00
Omit Accent (Czech only)			50.00	61.66

Appendix E

Same-Different Task: Analysis of Variance for the Native Language Comparison

Type III Sums of Squares

Source	df	Sum of Squares	Mean Square	F-Value	P-Value	G-G	H-F
lang	1	5.444	5 444	834	.3644		
age	1	393.361	393.361	60.237	.0001		
lang * age	1	2.778	2.778	425	5165		
Subject(Group)	68	444.056	6.530				
ccy-cvy	1	6 250	6 250	7 798	0068	0068	.0068
ccy-cvy * lang	1	.111	.111	.139	7108	7108	.7108
ccy-cvy * age	1	.028	028	035	8529	8529	.8529
ccy-cvy * lan	1	.111	.111	.139	7108	.7108	7108
ccy-cvy * Su..	68	54.500	.801				

Dependent wd cl.

Sound Isolation Task: Analysis of Variance for the Native Language Comparison

Type III Sums of Squares

Source	df	Sum of Squares	Mean Square	F-Value	P-Value	G-G	H-I
lang	1	2.507	2 507	498	4826		
AGE	1	47 840	47.840	9 511	0030		
lang * AGE	1	.062	062	012	9116		
Subject(Group)	68	342.028	5 030				
type	1	41.174	41.174	51 609	0001	0001	0001
type * lang	1	8.507	8 507	10 663	0017	0017	0017
type * AGE	1	8.507	8 507	10 663	0017	0017	0017
type * lang *	1	.063	063	078	7804	7804	7804
type * Subjec...	68	54.250	798				

Dependent. wd cl

Sound Isolation Task:
Analysis of Variance for the Foreign Language Comparison of English Subjects

Type III Sums of Squares

Source	df	Sum of Squares	Mean Square	F-Value	P-Value	G-G	H-F
test	1	5 868	5 868	1.346	.2509		
AGE	1	57 235	57 235	13 126	0006		
test * AGE	1	2 568	2 568	589	4460		
Subject(Group)	56	244 181	4 360				
type	1	65 401	65 401	47 659	0001	.0001	.0001
type * test	1	068	068	050	.8246	.8246	.8246
type * AGE	1	9 568	9 568	6.972	0107	.0107	.0107
type * test *	1	.501	501	365	.5480	.5480	.5480
type * Subjec.	56	76 847	1 372				

Dependent wd cl

Sound Isolation Task:
Analysis of Variance for the Foreign Language Comparison of Czech Subjects

Type III Sums of Squares

Source	df	Sum of Squares	Mean Square	F-Value	P-Value	G-G	H-F
test	1	21.356	21.356	2 514	1185		
AGE	1	107.339	107 339	12 635	0008		
test * AGE	1	15.606	15 606	1 837	1807		
Subject(Group)	56	475 722	8 495				
word cl	1	7 200	7 200	9 317	0035	0035	0035
word cl * test	1	.200	200	259	6129	6129	6129
word cl * AGE	1	2 006	2.006	2 595	1128	1128	1128
word cl * tes	1	2.006	2 006	2 595	1128	1128	1128
word cl. * Sub	56	43 278	773				

Dependent: type

Phoneme Deletion Task: Analysis of Variance for the Native Language Comparison

Type III Sums of Squares

Source	df	Sum of Squares	Mean Square	F-Value	P-Value	G-G	H-F
lang	1	56.889	56.889	13.552	.0008		
Subject(Group)	34	142.722	4.198				
Deletion	1	93 389	93 389	30 646	.0001	.0001	.0001
Deletion * lang	1	72 000	72 000	23.627	.0001	.0001	.0001
Deletion * Sub	34	103 611	3 047				

Dependent: Compact Variable 1

Phoneme Deletion Task:
Analysis of Variance for the Foreign Language Comparison of English Subjects

Type III Sums of Squares

Source	df	Sum of Squares	Mean Square	F-Value	P-Value	G G	H I
test	1	3 025	3.025	.633	4328		
Subject(Group)	28	133 708	4.775				
syll. type	1	213 136	213 136	54 123	0001	0001	0001
syll type * test	1	2 669	2.669	.678	4173	.4173	4173
syll. type * S ..	28	110.264	3 938				

Dependent. Syll. struct.

Phoneme Deletion Task:
Analysis of Variance for the Foreign Language Comparison of Czech Subjects

Type III Sums of Squares

Source	df	Sum of Squares	Mean Square	F-Value	P-Value	G-G	H-F
test	1	625	625	.166	6872		
Subject(Group)	28	105.708	3 775				
Deletion	1	2.336	2.336	2 070	1613	1613	1613
Deletion * test	1	1 736	1 736	1 538	.2251	.2251	2251
Deletion * Sub	28	31 597	1 128				

Dependent Syll struct

Nonword Spelling Task: Analysis of Variance for Overall Spelling Results

Type III Sums of Squares

Source	df	Sum of Squares	Mean Square	F-Value	P-Value	G G	H-F
lang	1	88.408	88.408	16 764	0001		
Subject(Group)	58	305 883	5 274				
wd.cl	1	1.008	1 008	690	4097	.4097	4097
wd.cl. * lang	1	12.675	12 675	8 668	0047	0047	.0047
wd.cl * Subje	58	84 817	1.462				

Dependent tot err.

Nonword Spelling Task: Analysis of Variance for Onset Spellings

Type III Sums of Squares

Source	df	Sum of Squares	Mean Square	F-Value	P-Value	G-G	H-F
lang	1	17.633	17 633	13 101	.0006		
Subject(Group)	58	78 067	1.346				
wd.tp.	1	22 533	22.533	19.526	.0001	.0001	.0001
wd.tp. * lang	1	8.533	8.533	7.394	.0086	.0086	.0086
wd.tp. * Subje ..	58	66 933	1.154				

Dependent beg cl

Nonword Spelling Task: Analysis of Variance for Word-Final Consonants

Type III Sums of Squares

Source	df	Sum of Squares	Mean Square	F-Value	P-Value	G G	H-F
lang	1	21 675	21 675	9 061	0039		
Subject(Group)	58	138.750	2 392				
end cl	1	18.408	18 408	20 901	0001	0001	0001
end.cl. * lang	1	7 008	7 008	7 957	0065	0065	0065
end cl. * Subj .	58	51 083	881				

Dependent end.cl