ONE SOUND SYSTEM OR TWO?

EVIDENCE FROM ONE INFANT LEARNING ENGLISH AND NORWEGIAN

By

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Abstract

To date, there is very little information about the early stages of bilingual language acquisition, and the information available is largely based on diary and anecdotal reports. In this thesis research the productions of one infant A, (1;9) learning English and Norwegian were analysed to provide information about the phonological system(s) acquired by a bilingual infant. Two issues where addressed; (1) whether an infant simultaneously acquiring two languages uses a single phonetic inventory or two separate systems, and (2) the effect a bilingual environment has on phonological acquisition.

Speech productions were collected via audio recordings during free play, parental diary records and the *MacArthur Communicative Development Inventory: Infants (*1989). All data were used to analyse the infant's lexicon. Transcriptions of the recorded data were compared across language environments and target languages in terms of phonetic inventories, syllabic inventories and substitution patterns.

At the lexical level, A took the language of the listener into account in that he used a higher proportion of English words in the English environment and a higher percentage of Norwegian words in the Norwegian environment. He did not differentiate phonetic production. A used a single phonetic inventory in his productions of English and Norwegian words. A cross-language influence was noted in his system, as it contained both English and Norwegian segments, such as [w], which is part of the English (but not the Norwegian) system, and [ø], which occurs in Norwegian, but not English.

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Acknowledgements

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CHAPTER ONE
LITERATURE REVIEW AND RESEARCH OBJECTIVE

Introduction

The acquisition of two languages is remarkable. In order to learn a language, a child must learn the physical mechanics of speech and the linguistic units and rules of the language, and "he must learn when and how to use the language in accordance with his own needs and the norms of his community" (Ferguson and Farwell, 1975, p.419). Changing this task by acquiring two languages is naturally expected to increase the difficulty involved; there is another system with other segments, a second set of linguistic rules, contrasts and constraints, and another community involved.

Claims made in the available literature on bilingual language acquisition are disparate and difficult to interpret, due to the different languages investigated and the different circumstances in which the languages were acquired. Most of the research consists of single-case studies that are anecdotal and impressionistic (McLaughlin, 1984). Group studies are rare and problematic for these same reasons, i.e., difficulty obtaining a matched group. The present study contributes to bilingual research because it is not anecdotal and it is specific to a single topic: phonology. As a single case study it offers focused investigation of a set of variables, which can be compared with results of other studies of bilingual language acquisition.

The following investigation of simultaneous phonological acquisition of Norwegian and English contributes to the existing knowledge base in the areas of both bilingualism and phonological acquisition. What does a child at the young age of 1;9 know about the phonological systems of Norwegian and English, which he has been hearing since birth? Will he demonstrate use of a single underlying system or dual systems? What effect is bilingual environment having on the of the phonology of each language?

In order to investigate these questions, background information is needed in a variety of areas. Chapter one will introduce the constructs 'bilingualism' and 'language mixing', the kind of evidence required to demonstrate differentiation of the two phonological systems, universal and language-specific predictions about phonological for language acquisition, nonlinear phonological theory as it pertains to acquisition, and the sound systems specific to Norwegian and English.

Chapter two explicates the method used in the investigation. Chapter three presents the results of the study, and chapter four is a discussion of these results. Original data is included in appendices.

Bilingualism

Historically, research in bilingualism has focused on the consequences of trying to learn more than one language. Bilingualism was denounced as harmful to the learner. Fuelling this belief was the notion that "the human

brain was not thought to be fit to learn more than one language, [and] therefore, bilingualism was acquired at the expense of other things" (Döpke, 1992, p.3). Bilingual acquisition was thought to be so taxing, that in order to have enough resources for learning two languages, extra resources would need to be "stolen" from other areas. In fact, normal development was not predicted for a child facing the challenge of acquiring more than one language.

Research and experience have demonstrated that most individuals are highly capable of acquiring two or more languages. "It has not been demonstrated that early bilingualism has positive or negative consequences for language development, cognitive functioning, or intellectual development (McLaughlin, 1984, p.225). Conclusive evidence is not available; research to date contains contradictory findings, often based on questionable methodology. However, the prevailing current popular belief is that bilingualism enhances language and general cognition.

Before discussing bilingual acquisition further, it is necessary to pin down the notion 'bilingualism' itself. In its simplest definition, 'bilingual' refers to an individual who has acquired two languages. Technical definitions are more complex; they are based on variables such as proficiency, which includes the issue of dominance, and when (relative to each other) the languages were acquired.

It is often assumed that bilingualism means equal competency in two languages. Although possible, monolingual proficiency in both languages is often not attained; usually one language is more dominant than the other (Taeschner, 1983). It has been suggested that "a language which is used in a wide variety of contexts tends to become dominant over a language which is used less often or in less significant circumstances" (Döpke 1992, p.2). Similarly, measurement of the bilingual's language proficiency is confounded in instances where the languages are used for different purposes. For instance, classification of bilinguals according to proficiency has lead to definitions such as 'receptive' bilinguals -- those who can understand the minority language -- and 'productive' bilinguals, who are able to talk in both languages (Döpke, 1992).

Bilingualism has also been differentiated according to temporal measurements, or the age and order in which the languages have been learned, resulting in classification according to simultaneous and sequential acquisition. Simultaneous acquisition differs from sequential acquisition, since the latter consists of a child or adult acquiring one language prior to acquisition of the second language. An adult acquires a second language, (L2) in a sequential manner. In this instance it is clear that a first language has been acquired before a second.

However, when the language learner is a young child, identification of such a two-step process has been more difficult. Although one language

may be introduced prior to a second, key to defining acquisition as sequential has been the fact that the first language must be essentially acquired before the second. Yet when does acquisition occur? Most research acknowledges the age limit of three years as the cut-off point dividing simultaneous from sequential acquisition. Although McLaughlin (1984) does not claim language is necessarily acquired by this point, he argues that "by the age of three, it would seem that the child has had a considerable head start in one language, [and] it is no longer a question of acquiring the two simultaneously" (p. 73).

Prior to distinguishing bilingualism in terms of simultaneous or sequential, bilingualism was classified according to the context in which the languages were learned, which in turn was assumed to result in different ways of encoding language in the brain. Weinreich (1953) differentiated bilingualism into three types: compound, coordinate, and subcoordinate.

Compound bilingualism results from the acquisition of the two languages in the same context. Weinreich proposed that, due to the concurrent use of the two languages, the two linguistic systems would be bound to a single set of meanings. Contrary to this, coordinate bilingualism occurs when the two languages are acquired in different contexts. Instead of a single conceptual system, the coordinate bilingual has two, one for each language. Subcoordinate bilingualism also has a single conceptual system; however, the bilingual's stronger language acts as a base through which the words of the weaker language are interpreted.

For the present study, bilingualism shall be defined as the simultaneous acquisition of two languages from birth, each being heard by the child to relatively the same degree. Under such conditions, the question posed is when the child differentiates between the two languages. Since direct measurement of language processing and knowledge cannot be done, the child's use of language must be observed. One of the most commonly used criteria in determining the bilingual child's differentiation of his two languages is 'language mixing' in speaking.

Language Mixing

Language mixing, by broad definition, is the combination of words from two languages (Vihman, 1985); more finely defined, it is "any type of linguistic interaction between two languages" (Lanza, 1992, p.634). Language mixing has been observed in infants and adults, 'partial' bilinguals and 'full' bilinguals, and when the bilingual is speaking to a monolingual or to other bilinguals. However, disagreement exists about whether or not the language mixing in child speech is functionally different from the 'code-switching' found in adult speech. According to Lanza, code-switching "occurs in bilingual discourse, and involves the mixing of languages within and across utterances or sentences" (1992, p.636). Code-switching is not regarded as abnormal or incorrect practice but, rather, the contrary. Code-switching, which involves the ability to vary pronunciation, lexicon, and

grammar according to features of the speaking context, is part of every adult speaker's native competence.

Language mixing in a child's speech, on the other hand, has been used to indicate inaccurate production, or the child's lack of differentiation of the two languages; it has been taken to imply that there is a single underlying system governing the child's production. Language separation in the child's speech has been viewed as an indicator of successful differentiation, or two separate systems underlying production.

Language mixing has been found at a variety of language levels: lexical, syntactic, morphological, semantic, and phonological (Leopold, 1949; Pye, 1986; Oksaar, 1975; Vihman, 1985, Rūķe-Draviņa, 1965). "Mixing seems to occur most frequently in the lexicon whereas it is most unlikely to happen in the sound system" (Meisel 1989, p.14). Much of the relevant literature seems to support this proposal, since most of the research deals with lexical mixing.

Fundamental to a discussion of lexical mixing by bilingual children has been research by Volterra and Taeschner (1979), who claim language mixing to be a universal phenomenon experienced by all bilingual children. They proposed three stages through which children pass during bilingual language acquisition. In Stage 1, the child possesses only a single lexical system. This system is characterized by containing words from both languages. It is not until Stage 2 that the child separates the system into two different

lexicons. Typically, the child does not mix words from the two languages in his productions, but applies the same syntactic rules to both lexicons. It is not until Stage 3 that the child is said to have differentiated the two languages. That is, the child recognizes both a separate lexicon and separate syntax for each language. Finally, Volterra and Taeschner claim that it is not until the end of this stage that the child is able to speak both languages "with the same linguistic competence as a monolingual child, with any person. It is only at this point that one can say a child is truly bilingual" (1977, p.326).

Not all researchers agree that language mixing is universal. Meisel (1989) argues against Volterra and Taeschner's three- stage model. He concludes that the facts do not "represent convincing evidence in favour of an early phase of mixing through which all children would have to go" (p. 17). Although some children's speech demonstrates a period of confusion (cf. Murrel, 1966; Rūķe-Draviņa, 1965), others' does not (Oksaar, 1975).

Meisel is also unconvinced that language mixing necessarily implies a lack of differentiation of languages. Other factors suggested to influence language mixing include: production variability, language dominance, limited lexicon, and mixed input.

Production Variability

Variability in language production occurs in the speech of all learners. For this reason, mixing may not necessarily imply the effects of bilingualism *per se*, but rather be demonstrative of typical language acquisition. For instance, Leopold (1949) examined his daughter Hildegard's acquisition of German and English and explained that, although phonetic mistakes were evident in her productions, they were not necessarily due to the effect of bilingualism. The errors might have occurred in a monolingual setting as well.

Limited Lexicon

Language mixing may occur because the child lacks a word in one language and so borrows from the other. A correlation would then be implied between language mixing and language repertoire. Instead of a decrease in amount of mixing as an indication that the child is learning to separate his/her languages, it may be that the child is actually borrowing less between languages as his/her repertoire builds (Genesee, 1989; Lanza, 1990).

Similarly, mixing may result from a child over- or underextending a word, common in the speech of young monolingual children. In fact, limited lexicon is often cited as an explanation of overgeneralization (Rescorla, 1980).

> Bilingual children may overextend longer than monolingual children because they hear more instances of particular nominals being used in specific contexts, whereas monolingual children are likely to hear the same nominals used in extended contexts.
> (Genesee, 1989, p. 168)

Underextenstion may occur if a lexical item from one language is used more frequently, or was the first label used for an object or action; in this case, some children may identify it with the referent (Genesee, 1989). Volterra and Taeschner (1978) give an example of an infant who had different meanings for Italian and German 'there': *la* (Italian), which she used for things that were not visible at the time of speaking, and *da* (German), used when things were present and visible.

Linguistic Factors (Selection and Avoidance)

"Mixing may also be due to structural linguistic factors; i.e. the word is simpler and more salient in the one language than the other" (Genesee, 1989, p. 167). One of the universal operating principles offered by Slobin (1973) is that, although both systems are available, one is more complex and strains the child's ability, so the simpler device is chosen. Monolingual research has demonstrated that children as young as 1;2 to 1;3 are selective in the words in which they attempt. Children may select words and sounds to attempt and are more likely to acquire words consistent with their phonological inventories (Macken and Ferguson, 1983; Schwartz and Leonard, 1982). According to Schwartz, Leonard, Frome Loeb, and

Swanson, (1987), "selectivity and avoidance reflect a noteworthy interaction among the child's perception, storage and production" (p. 416).

Language Mixing in Input

Language mixing in parental input to a child has been commented on extensively in the bilingualism literature. Several authors emphasize the importance of social/sociolinguistic as well as purely linguistic factors in explaining interference and language differentiation (Döpke, 1992; Lanza, 1990; Meisel, 1989; Redlinger & Park, 1980). Much of the literature indicates that consistent separation of the two languages in the home is required for optimal acquisition, that is, reducing the amount of interference (Döpke, 1992; McLaughlin, 1984). Lanza (1990) proposes that "'differentiation' and 'bilingual awareness' must be defined in a relative manner, that is, not merely as the separation of both languages along strictly formal grounds" (p.100). She proposes that the context of the child's conversation needs to be considered, and, unfortunately, it is often not accounted for. According to Genesee, the relationship between input and rate or type of mixing is difficult to determine from the available research "since descriptions of the language-input conditions are either totally lacking or, at best, are general and impressionistic" (1989, p. 170).

In conclusion, interpretation of mixing, (primarily at the lexical level), purely as demonstrating a lack of linguistic awareness by the child remains

controversial. At the phonological level as well, it may be that the presence or absence of segment mixing across the languages will not be sufficient to determine whether the child is able to differentiate between his two languages. Interpretation of phonological mixing in one language, would require productions and substitutions explainable by the specific influence of the other language.

One System or Two?

Many researchers consider lexical analysis informative with regard to determining whether the bilingual is using a single system or two. For instance, Volterra and Taeschner (1978) proposed that the bilingual child's lexicon will initially lack cross-language synonyms, which will cause mixing in early word combination. This hypothesis was tested by Vihman (1985), who found her son progressed gradually "from a single lexicon containing few corresponding terms to a dual lexicon in which the smaller proportion of English terms--reflecting R's lower exposure to English--was very largely duplicated by Estonian terms" (p. 301).

A second avenue, receiving more support, involves quantification--rather than description--of language mixing. Such investigation focuses on determining the percentage of use of each language according to environment. Genesse proposes that

> if items from both languages are used indiscriminately in all contexts of communication by the bilingual infant, this would provide evidence for the unitary-system hypothesis...In other words, there should be no differential distribution of items from the two languages as a function of the predominant language being used in different contexts. (1989, p. 165)

If language use differs as a function of context, two underlying systems would be suggested. It is not simply the presence of language mixing, but rather the percentage of mixing in relation to context that is the important variable (Pye, 1986; Vihman, 1985).

What evidence is required to determine differentiation at the phonological level? Since Genesee refers to whole-word productions or utterances, I am hesitant to apply his proposal to sound production. On the one hand, Macken and Ferguson (1973) claim that an occurrence noted at any of the level of language (i.e. lexical, morphological, etc.) is preceded by similar development in the area of phonology. However, Schnitzer and Krasinski oppose this position, claiming that "having separate lexicons in no way implies the use of separate phonological systems" (1994, p.586). According to Schnitzer and Krasinski (1994), a single system is indicated by any one of the following characteristics in a child's productions:

> (i) failure to use sounds which occur in only one of the two languages
> (ii) use of sounds impossible in L1 (but found in L2) in L1 lexical items
> (iii) use of contextual variants (allophones) in the contexts permissible. (pp. 586-587)

In order to indicate differentiation of the two phonological systems, Schnitzer and Krasinski state that the child must appropriately use the allophones of all the phonemes acquired in all relevant contexts of both the languages. They argue that correct use of the allophones must be across all cases. "The mere correct use of an L1 sound (which did not normally occur in L2) in an L1 word, in itself should not constitute evidence for differentiation" (Schnitzer, & Krasinski, 1994, p.587).

In the present study, it is not possible to meet these requirements due to the young age of the subject. Allophonic control is highly variable, and appears much later in acquisition than control of phonologically contrastive segments. Schnitzer and Krasinski have specified productions that will not allow determination of language differentiation in early phonological development for any child.

Phonological Acquisition

In order to examine effects bilingual language learning has on phonological system construction by a child acquiring Norwegian and English, the terminology and assumptions of phonological acquisition research need to be outlined. A theoretical framework must be chosen from which to analyse the sound system(s). Finally, the two target systems must be described in relative terms to allow for comparison.

Universal versus Language-Specific Predictions

Research on phonological acquisition, as one aspect of language acquisition, is framed by several different viewpoints. The universal perspective, most commonly associated with Jakobson (1968), proposes that there is a universal pattern to phonological acquisition. The "relative chronological order of phonological acquisitions remains everywhere and at all times the same" (Jakobson, 1968, p.46). Jakobson proposed the Law of Irreversible Solidarity to predict the order of acquisition. Accordingly, the first acquired sounds are those most frequent in the world's languages, while those relatively infrequent are acquired later. The acquisition process is dependent upon the acquisition of feature contrasts rather than specific segments. Those features that are more basic, or unmarked, are the first to be acquired.

Specifically, Jakobson predicted that acquisition begins with the child establishing a consonant-vowel contrast, followed by a vowel-vowel contrast, a nasal-oral distinction, then a labial-alveolar contrast. Labial is predicted to be the first consonant place of articulation, while a mid, open vowel is expected to initiate vowel acquisition. Although rate of acquisition may vary, the order of acquisition should be the same across all children.

According to the language-specific perspective, phonological acquisition is not as universal as Jakobson predicted. Instead, the specific characteristics of a child's target language influence phonological acquisition.

Phoneme frequency in the child's target language, rather than frequency across the world's languages, has an effect on the order of segment acquisition. According to the language-specific perspective, the more frequently used segments of a language end to be the first acquired. Those segments rarely heard by the infant tend to be the later segments in the infant's repertoire. Although children's initial systems are often similar, the language-specific perspective predicts signs of the target language to be evident in early productions. According to the language-specific view, as children make the transition from babbling only to their first productions of words, phonetic particularities of the different adult languages begin to exert their influence.

In terms of bilingual phonological acquisition, the predictions of the universal and specific-language perspectives are not completely different. The universal position predicts that, although acquiring the sound systems of two languages, a bilingual child initially will possess a single phonological system. This system would be similar to that used by all children acquiring language, monolingually or bilingually, irrespective of the language(s) acquired. The language-specific position predicts that the phonological system(s) of the bilingual child will display influence from the specific languages acquired. However, the nature of the underlying systems is difficult to predict. One possibility is that, since the child has the pressures of two different systems, two underlying systems will be used, each system

predicted to develop according to the most frequent sounds used in each language. A second possibility is that a single system will be used by the bilingual learner. In the latter case, the order of acquisition would depend on the combined frequency of phonemes between the two languages; the resulting developing system may or may not follow the frequency predictions of either one of the target languages.

Despite the predictive ability of both the universal and language-specific perspectives, neither can completely account for the variability found in phonological acquisition data. In fact, acquisition appears to be influenced by both difficulty and saliency, as well as individuality (Slobin, 1973; 1985). Although Slobin was discussing grammatical acquisition, his proposal links universal claims with claims involving frequency of occurrence or saliency in a specific language. Further support for multiple factor explanation of phonological acquisition is found in crosslinguistic and second-language acquisition data.

In an investigation of the order of acquisition of English vs. Quiché Mayan, Pye, Ingram and List (1987) proposed that the sound's functional load is more important than a segment's frequency within a language. Pye et. al explain the functional load as the importance a segment has to the phonological system the child is acquiring. The number of oppositions or minimal pairs a segment occurs in determines its functional load. Although a segment may be frequent in a language, if it is not functionally important, i.e.

has a low functional load, it will not be one of the first segments acquired. For example /ð/, a very frequently produced segment in English, is one of the later segments to be acquired; despite its frequency, it has a small functional load.

From a bilingual perspective, Oksaar (1975) proposed that frequency of occurrence is one variable affecting the acquisition of the Swedish toneme system, during bilingual acquisition of Swedish and Estonian. Oksaar reports that children acquire the quantity system of Estonian before the system of segmental sounds has been fully mastered.[1] In Swedish the reverse is true; the toneme distinction, (accent 1 and accent 2),[2] is not acquired until after the segmental system has been established (both by the bilingual children of the study and by monolingual Swedish children).

Oksaar suggests the reason for this difference is that "the acquisition of the phonemic system must not be followed apart from the semantic-communicative system" (1975, p.379). She points out that the Estonian quantity distinctions occur with a high frequency and are very important for the child to learn, because they are relevant to the entire form system and, very frequently, to lexical items. On the other hand, the child is exposed to the Swedish distinctions less often, since they cover less frequent forms, or

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[1] In Estonian, both vowels and consonants have 3 distinctive degrees of length--short, long, and overlong--that build phonemically distinct quantities.

[2] Accent 1 and accent 2 are explained in the Norwegian phonology section of this chapter.

forms that are acquired at a later stage (e.g. nouns compounds). Therefore, Oksaar views both frequency and functional load were viewed as factors influential on phonemic acquisition.

Results from second-language acquisition studies are similar, although their relevance to bilingual acquisition is not clear. For instance, Hecht and Mulford (1982) investigated the interaction of language transfer and general developmental factors in the acquisition of a second language phonology. According to the transfer position, first language knowledge affects the acquisition of the second linguistic system. The developmental position explains that second language acquisition of a language is similar to acquisition of that language by monolingual learners. Alone, neither position was found adequate to explain the errors and substitutions produced in the second language of a 6-year-old native Icelandic speaker who was learning English as a second language. Hecht and Mulford found that order of acquisition was best explained by the transfer position, which predicted that "those allophones common to both languages should be easiest, completely new or those requiring adjustments more difficult" (p. 317). On the other hand, substitutions were better explained by the developmental position; that is, the child used substitutions for those phonemes acquired last by monolingual learners of the target language.

Nonlinear Phonological Theory

Phonological development has been described and explained from the perspective of a number of theories. For this thesis, nonlinear phonological theory (as explicated by, e.g., Clements, 1985; Goldsmith, 1976) is used for the analysis of the child's phonological development in terms of phonemic inventory and syllabic structure.

Nonlinear phonological theory makes testable predictions about the acquisition of words, syllables, segments, and features. This framework continues (in the tradition of earlier theories) to describe the acquisition of segments in a sequential manner; going beyond earlier theories, it also offers the ability to examine the relationships among segments (Bernhardt & Stoel-Gammon, 1994). Instead of distinct feature bundles defining a segment, a hierarchical arrangement of the phonological components is proposed, thus establishing a relationship between segment features. In other words, there are links or connections between adjacent nodes and dominating nodes, where a 'node' represents a group of features (Clements, 1985; McCarthy, 1988).

Nonlinear phonological theory assumes that a child begins the process of phonological learning with the unmarked syllable shape CV and some default feature values. From this point, the child is thought to progress in an additive manner, building rather than deleting rules. (Deletion of rules as phonology develops is an assumption of process-based accounts of

phonological acquisition such as Stampe's ([1969] Natural Phonology.) The child is actively involved in acquiring other syllable shapes and increasing the inventory of segments to fill in the consonant, (C), and vowel (V) slots. Two distinct tiers of hierarchical organization are suggested, one for the segmental units, and a second for prosodic structure (structure above the segmental level).[3] The relationship between the tiers is not necessarily one-to-one, because acquisition involves setting parameters for syllable structure as well as features (Bernhardt, 1992). Phonological rules or processes result from, and are constrained by, principles of association between the various autonomous levels, and fewer rules are needed and the motivation for the rules is provided (Goldsmith, 1976).

The feature geometry for the English consonant system as represented by Bernhardt (1992), is displayed in Figure 1.1.

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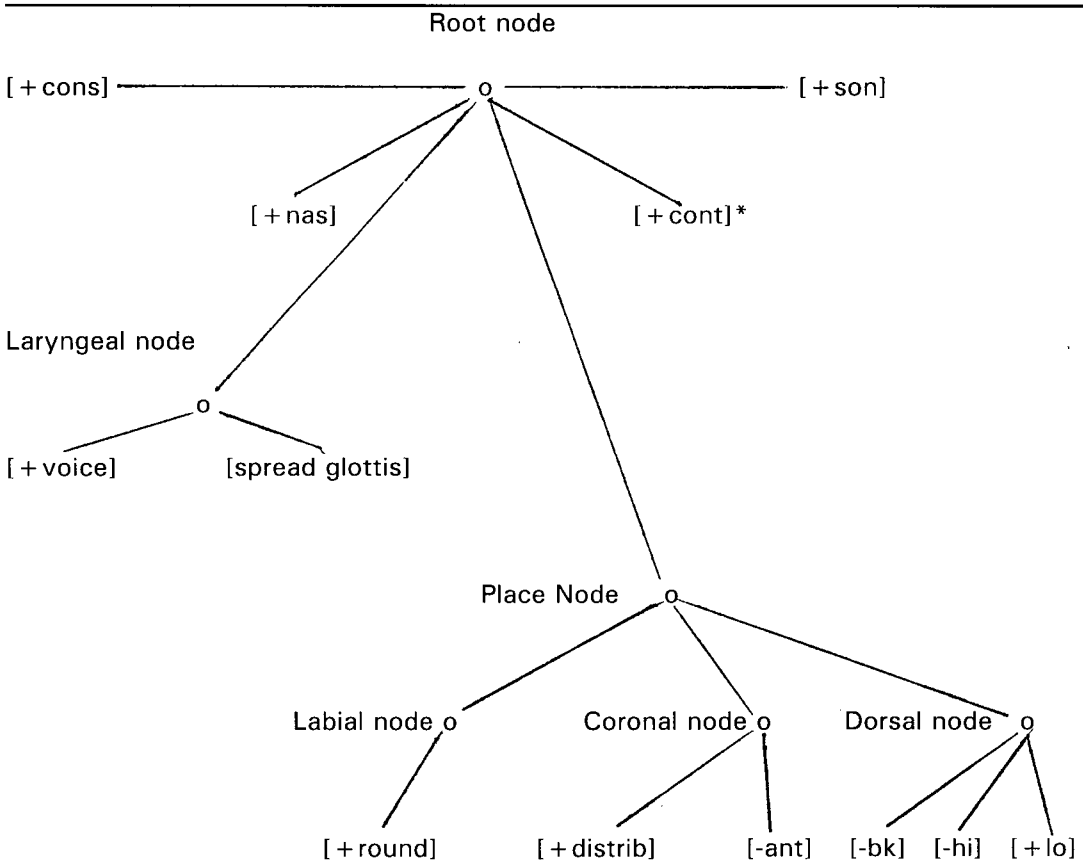
[3] In fact, three tiers have been proposed. Separate tiers have been suggested for consonants and vowels (Bernhardt and Stemberger, in prep).

Figure 1.1: Feature geometry for English



Note: Marked features are indicated on terminal noes with plus or minus specification. Labial, Coronal, and Dorsal nodes are considered monovalent. The Root node designates the segment. It links into the prosodic tiers above. *Affricates are designated as 'complex segments'. 'Complex' is a mnemonic describing the branching structure of affricates with respect to [continuant], (The term is from Lombardi [1989] but does not imply her analysis.

(taken with permission from Bernhardt, 1992)

Phonological Systems

English

Consonants

The English consonant system consists of 24 segments. Manner of articulation includes plosives, nasals, fricatives, affricates, glides and liquids (one rhotic, one lateral). Places of articulation include bilabial, labiodental, interdental, alveolar, alveopalatal, palatal, velar, and glottal. As well as distinguishing segments by manner and place of articulation, English plosives and fricatives include both voiceless and voiced segments.

Table 1.1 outlines the English consonant system.

Table 1.1: English consonants (phonemic norms)

	Place of Articulation							
Manner of Articulation	Bi-labial	Labio-dental	Inter-dental	Alveolar	Alveo-Palatal	Palatal	Velar	Glottal
Plosive	p b			t d			k g	
Nasal	m			n			ŋ	
Fricative		f v	θ ð	s z	ʃ ʒ			h
Affricate					ʧ ʤ			
Glide	w					j		
Liquid				r l				

(adapted from Stoel-Gammon & Dunn, 1985)

Vowels

The vowel system of English consists of 12 different segments (refer to Table 1.2). Vowel segments differ according to place (front, central, or back), height, (high, mid, or low), and tenseness (tense or lax). In terms of features, classification is according to [+/- high], [+/- back], [+/-] tense, and [+/- round]. The diphthongs and r-coloured vowels of English--/ɑi, ʌi, ɔi, ɑʊ, ʌʊ/ and /ɚ, ɝ/--are not represented in Table 1.2. The diphthongs /ɑi/ and /ɑʊ/ are pronounced [ʌɪ] and [ʌʊ], respectively, in Canadian dialects. While not usually considered true diphthongs, the vowels /e/ and /o/ are most typically pronounced as /ɛi/ and /ɔʊ/, respectively.

There is geographical dialect variation in contrasts among the low vowels /a, ɑ, ɒ/ is noticeable in the vowel system of English speakers. In North America, a given dialect has either /ɑ/ or /a/ and /ɒ/. For example, *father* can be [fɑðɚ] or [faðɚ], while the corresponding pronunciations of *bought* would be [bɑt] and [bɒt]. This needs to be considered when interpreting the acquisition of these vowels in English.

Table 1.2 - English vowel classification

Feature	Front	Central	Back
High			
Tense	i		u
Lax	ɪ		ʊ
Mid			
Tense	e		o
Lax	ɛ	ə ʌ*	ɔ
Low			
Tense		a▫	
Lax	æ		ɑ▫ ɒ▫

(adapted from Stoel-Gammon & Dunn, 1985)

* Note that this classification differs from IPA, which categorizes [ʌ] as a mid back unrounded vowel.

▫ Note that there is not a three-way distinction among these vowels in any single dialect of English.

Normative Acquisition Data

Normative age data for phonological skills development are limited. Paschall (1983) found the most frequently occurring consonants of an 18 month-old child to be /b, k, t, d, m, l/ (in descending order of frequency) while /v, ʒ, dʒ, j, ʔ/ either did not occur or appeared with a frequency of less than 0.5% of total consonants produced. The most accurately produced consonants were /b, m/ (90% and 84%, respectively) followed by /j, h, f, d, n, w, p/ (all produced with accuracy between 50 and 75%).

Stoel-Gammon (1987) collected data representative of 2-year-olds. She identified the following abilities as 'typical' of a 2-year-old, based on her sample of 33 children.

> He or she can:
> 1. produce words of the form CV, CVC, CVCV, and CVCVC;
> 2. produce a few consonant clusters in initial position and maybe one or two in final position;
> 3. produce 9-10 different consonantal phones in initial position, including exemplars from the classes of stops, nasals, fricatives, and glides;
> 4. produce 5-6 different consonantal phones in final position, mostly stops but also a representative from the nasal, fricative, and liquid sound classes;
> 5. match the consonant phonemes of the adult word at a level of 70% correct. (Stoel-Gammon, 1987, p. 327-328).

Normative data on the acquisition of vowels is even more limited than that on consonants. This may be due to the fact that vowels are known to be "mastered earlier than consonants and, even at young ages, tend to evidence fewer errors" (Stoel-Gammon, 1991, p.27). Paschall (1983) found that, for 20 monolingual children aged 16-18 months, the most frequently produced vowels were /ɪ, æ, ɑ, o, i/ (each 4% of total segments, except the latter, which was 6%). Vowels produced with the highest degree of accuracy were / ɑ/ at 81%, and /ʊ, i/ both greater than 75%, while /e, ɛ, ɝ, aɪ/ were the least correctly produced vowels, all less than 50% accurate. Important to note is the fact that Paschall's results differ from previous research reported in the phonology literature. This appears to be due to the differing ages of subjects, and Paschall explains that the results indicate the possibility of a rapid growth in vowel acquisition between the 18-month and

2-year-old child. This hypothesis seems probable, and if true, the results of the present study may not conform with the normative data at either the 18-month or 2-year-old level.

According to Stoel-Gammon (1991) most vowel targets are produced correctly by the age of 3 (often the only error found for the r-coloured phonemes /ɝ/ and /ɚ/).

Norwegian

Consonants

Contrary to the abundance of research on the acquisition of the English phonology, the study of Norwegian phonological acquisition is sparse. Few publications contain reference to order of acquisition, frequency of occurrence, or even the target inventory. As shall be discussed further, discrepancies were noted in the existing literature.

According to Vanvik (1971), the consonant system of Educated Eastern Norwegian consists of 22 consonants (refer to Table 1.3). The Norwegian inventory contains plosives, nasals, fricatives, liquids, and one glide. Places of articulation include bilabial, labiodental, dental, alveolar, retroflex, alveopalatal, palatal, velar and glottal.

Table 1.3: Eastern Norwegian consonants (phonemic norms)

Manner of Articulation	Bi-labial	Labio-dental	Dental	Alveolar	Retro-flex*	Alveo-palatal	Palatal	Velar	Glottal
	Place of Articulation								
Plosive	p b		t d		ʈ ɖ			k g	
Nasal	m			n	ɳ			ŋ	
Fricative		f v	s			ʃ	ç		h
Glide							j		
Liquid				l r					

(adapted from Haugen, 1984)

* Retroflex is not, strictly speaking, a place, but rather a tongue configuration.

Vowels

The vowel system of Norwegian consists of 9 vowels, as shown in Table 1.4., and three diphthongs. Vowel classification is shown according to advancement (front, central or back), tongue height (high, mid, low) and rounding.

Table 1.4, has been adapted from various descriptions of the Norwegian vowel system written by Haugen (1957, 1969, 1982, 1984). Although a predominant author of phonological description of Norwegian, Haugen's vowel descriptions are contradictory. For instance, in his book *Beginner Norwegian*, Haugen (1957) informs the reader that Norwegian consists of nine monophthongs [a: e: i: o: u: y: æ: ø: å:] and six diphthongs:

Table 1.4 - Vowel classification of Eastern Norwegian (phonetically)

Feature	Front		Back
High			
Tense	i	y	u
Lax	ɪ	ʏ	
Mid			
Tense	e	ø	
Lax	ɛ		ɔ
Low			
Lax	æ		ɑ

Note: According to Haugen, [y ø] are partially unrounded, while [y] is "overrounded".

[ai: ei: ui: æu: øy: åi].[4] The reader is also informed that Norwegian has short values "similar to those of the corresponding long vowels, but... shorter and crisper, like English *e* in *bet* or ɑ in ɑ*bout*" (Haugen, 1957, p.13). In other words, his 'short'-'long' designation (also used by Vanvik, 1971, and Lanza, 1990), phonetically includes a tense-lax distinction (Susanne Gilbert, personal communication, confirmed my own transcription of Norwegian speakers). In his *Norwegian English Dictionary*, Haugen (1984) describes the vowels (and consonants) of Norwegian in terms of phonemic symbols, IPA symbols, a Norwegian keyword, and an English keyword. The list of segments differs from previous descriptions (and, again, the phonetic brackets are used incorrectly); diphthongs include: [ai], [ei], [ui], [øy], [oi],

[4] Haugen uses phonetic brackets to represent these vowels, but I have come to the conclusion he is using orthographic symbols in his descriptions.

Haugen provides many English keywords whose pronunciations do not match the IPA symbol meant to represent them. For instance, he lists [a] as the phonemic symbol matched with the IPA [ɑ], the Norwegian keyword *kɑtt,* and the English keyword *cut*.

Finally, in *The Norwegian Language in America*, Haugen (1969) claims that, although there are dialectal variations, the most common system of Norwegian vowels is "one with nine vowels and three favourite diphthongs.... i, y, u; e, ø, o; ɑ, ˚ɑ; ei, øy, œu" (p.423).[5] I have chosen to use Haugen's 1984 description of the vowel system, since it is the most recent, and it is clearly specified as representing the typical East Norwegian (Oslo) system (the standard dialect spoken by A's mother). However, I have interpreted his descriptions to display the Norwegian vowel system with IPA symbols (refer to Table 4).

Other vowels occur phonetically, but are not contrastive. For example, [o] is an allophone of /ɔ/. As in English, Norwegian has [ə] in unstressed position. Not represented in Table 4 is the phonemic quality of vowel length in Norwegian (e.g. /ta:k/ *tak - roof* vs. /tak/ *takk - thank you*). According to Haugen (1984), vowel length increases the vowel duration by as much as double as well as making the vowel "tenser, less central, and

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[5]Haugen's description has been presented here in the same manner found in his book. The first symbol in the last diphthong listed is difficult to interpret; possibly [œ] or [ɑe]. Typically, Haugen represents symbols orthographically, yet, neither of these symbols are members of the Norwegian alphabet.

mildly diphthongal" (p.37). Recall that the long-short contrast is also pronounced as tense versus lax.

At the suprasegmental level, Norwegian possesses two different accents, or tones, generally referred to as Accent 1 and Accent 2. Accent 1 tends to occur on monosyllabic words and, in Eastern Norwegian, has a low rise pitch movement (Lanza, 1990). Accent 2 is characterized by the addition of the 'tone', a more complex pitch pattern. The 'tone' occurs "only in connection with stressed syllables and only in words that have at least one syllable following the stress" (Haugen, 1984, p.39):[6]

> phonetically [Accent 2] is characterized by having a pitch pattern that peaks (or dips) after the primary stress peak, either at the beginning of the second syllable, or as a separate peak, in the middle of it... There is marked regional variation in the phonetic pattern of the two accents, but 2 is in general more complex, since the pitch is out of phase with the stress.
> (Haugen, 1982, p. 22)

For example, the following minimal pair is distinguished only by tone, or word accents:

> *bønder* /bønər/ - *farmers* - has accent 1
> *bønner* /bønər/ - *beans, prayers* has accent 2.

Normative Acquisition Data

Normative data on phonological acquisition of Norwegian is very scarce. The first, and apparently only, study of Norwegian phonological

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[6] Stress in Norwegian and English is similar phonetically and functionally. In Norwegian, a stressed syllable MUST contain a lengthened segment, either a long vowel, or a long consonant (Haugen, 1984).

acquisition is a diary study by Vanvik (1971). Vanvik found that, during his daughter's first year, Hilde produced all the phonemic consonants of Eastern Norwegian, with the exception of retroflex /ʈ, ɖ, ɳ, ɭ/, trill /r/ and the fricatives /f, ʃ, ç/. Interestingly, Hilde produced no new consonants during the second year; previously missing segments from her production continued to be absent. On the other hand, her production contained exemplars of all of the phonemic vowels of Norwegian except /ʏ/ during the first year (although control of the vowels was reported to continue development). This probably means that her productions were variable. Diphthongs were noted to be acquired later, with /øy/ and /ai/ still lacking at the end of the second year.

With regard to toneme production, by the age of 1;9.8 months, Hilde had "well developed tonal movements in words with toneme 2 (fall-rise), in particular a well developed fall (Vanvik, 1971, p. 289).

Comparison of English and Norwegian

Segments

The phonetic inventories of English and Norwegian are, in fact, quite similar to one another. Specific segmental differences in the consonantal systems include the absence of /w, z, ʒ, θ, ð, ʧ, ʤ / from the Norwegian system, and the absence of /ç/ in English. In addition, Norwegian has an entire class of retroflex consonants /ʈ, ɖ, ɳ, ɭ/ that are not found in most

dialects of English. Also differing is the English /ɹ/ vs. the trill /r/ of Norwegian. However, Haugen notes that the trill /r/ in Oslo "rarely gets more than a single tap, except when it is geminated" (1984, p.42).

Place of articulation of the plosives is also different. Norwegian segments /t, d, n, s, l/ are produced with a dental articulation rather than alveolar as in English. As well, although difficult to detect, Norwegian plosives can be lengthened. Consonant lengthening seems to function to constrain vowel length. "Before long consonants the vowel must be short; long vowels and long consonants cannot coexist in the same syllable" (Haugen, 1984, p.38). For example *bitt* /bit/ *vs. bit* /bi:t/.[7] Plosives in both languages share the same manner of articulation contrasts; voiced, voiceless aspirated, and voiceless unaspirated (the voiceless becoming unaspirated following [s] and postvocalically, and the Norwegian voiced segments having a slight devoicing initially and finally).

Order of acquisition of segments shows that the segments differing between the two languages are also, typically, the last segments acquired in each language. This factor is influential in determining any differences between the two systems, since the subject of this thesis research, due to his age, is not expected to have acquired these segments.

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[7] Orthographically, consonant gemination signals lengthening of a consonant. Phonetically, the contrast here is [bɪt] versus [bi:t].

Comparison of the vowel systems is more difficult, because investigation of phonological acquisition, in both monolingual and bilingual research, has focused primarily on consonant systems. Neglect of the vowel system may be due to a number of factors, including: the difficulty tracking vowels during the relatively quick rate of acquisition, dialect variation, variability of productions, and difficulty in determining if a contrast is present between vowels or not. Until recently, the lack of adequate instrumental technology contributed to the vowel description difficulties.

Despite the lack of investigation, or perhaps because of it, many researchers have not paid particular attention to vowel acquisition. However, evidence indicates that consonant and vowel systems are two different systems. Not only are they used differently, (i.e in syllabic structure), research shows that the two systems are acquired at different rates.

Studies of monolingual acquisition report that acquisition of the vowel system precedes acquisition of the consonant system. Bilingual research also indicates vowel acquisition differs from acquisition of the consonant system. In a study involving simultaneous acquisition of Spanish and English, Schnitzer, and Krasinski (1994) found their subject used a single consonant system covering both Spanish and English until approximately 2;7. At this time, although not approximating the adult systems of English and Spanish, the child displayed two consonant systems. "In contrast to the

patterns described for the consonants, the vowels [displayed] no stage of unitary-system patterning" (p.617).

A few specific segmental differences between the Norwegian and English vowel systems are relevant to the present thesis: that is the presence of front rounded segments in the Norwegian system.

Since the two languages possess different phonemic segments, the organization, or layout of the vowel system will also differ. Lieberman explains that:

> different dialects and languages make use of different acoustic partitioning of the acoustic vowel space delimited by the quantal vowels [i], [u], and [a] (Lieberman, 1976, 1977)... the process of forming appropriate vowel categories for a specific language is gradual and plastic.
> (Lieberman, 1980, p. 140).

The arrangement of the vowel space may be different for the vowel systems of English and Norwegian. According to Haugen (1984), the Norwegian vowel space is smaller in size; the Norwegian high vowels are not as high as the English high vowels while the Norwegian low vowels are not as low as the English low vowels. High Norwegian vowels fall between the high tense and high lax vowels of English.[8] The low Norwegian vowels are just above the low English vowels. Haugen also distinguishes the Norwegian vowels in terms of 'spread', 'round' and 'overround' rather than the tongue placement

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[8] Since Haugen does not differentiate between tense and lax vowels as members of the Norwegian vowel system, he does not refer to the lax vowels in terms of placement within the vowel space.

distinction used for his classification of English vowels (i.e. front, central and back).

A final difference between the two languages is the tonemic system of Norwegian, which is not found in English. Interestingly, Haugen comments that, although unnatural and incorrect, "it is possible to speak Norwegian without tone.. since most of the pairs of words that are distinguished by tone are not likely to be confused in context" (Haugen, 1984, p.39).

Syllable and Word Structure

Like English, the syllabic division of Norwegian requires each syllable to have a nucleus. The nucleus is generally a vowel, but unstressed consonants [+sonorant] [+continuant] may also function as a syllabic nucleus (i.e. /l, n, r/). Both languages contain the vowel /ə/, which exists solely in an unstressed position. In Norwegian, "any long vowel or diphthong may constitute a syllable by itself; short vowels require a following consonant unless they are unstressed" (Haugen, 1984, p.37). Both languages include a variety of word shapes that contain both open and closed syllables.

Both languages have consonant clusters limited to three phonemes; if there are three, the initial consonant must be /s/. Unusual to the consonant clusters of English are the plosive + nasal and plosive + fricative combinations that are accepted in Norwegian (e.g. *kne* [kne] *knee; fnugg* [fnug] *speck*) are

not possible in English. Note that this makes the number of acceptable clusters in Norwegian considerably greater than that allowed by English constraints. Possible consonant clusters of Norwegian in "word-initial" (more likely syllable-initial) position are:

p-: pl, pr, pj
b-: bl, br, bj
m-: mj
f-: fn, fl, fr, fj
v-: vr
t-: tv, tr, tj
d-: dv, dr, dj
n-: nj
s-: sm, sn, sp, spl, spr, spj, st, str, stj, sk, skv, skl skn, sv, sl
r-: rj

Clusters found inter- and post-vocalic in Norwegian, but not in English, include: [mn, ngn, vn, psk, tsk, tsk].

Research Objective

The purpose of the investigation is to investigate the sound production of a single infant simultaneously acquiring Norwegian and English. To date, there is very little information about the early stages of bilingual phonological acquisition, and the information available is largely based on diary and anecdotal reports.

This study will use phonological analysis of transcriptions in order to investigate whether an infant at approximately 1;9 simultaneously acquiring two languages, is using a single phonological system or two separate

systems to guide his productions. Both context (i.e. target word), and environment (i.e. language used by the conversational partner), need to be considered when investigating whether a single or dual system underlies phonological production.

CHAPTER TWO
METHOD

Overview

A naturalistic single-subject study was conducted to investigate the phonological development of an infant acquiring English and Norwegian bilingually. Information about the infant's phonological productions was gathered from his parents via a diary and through a questionnaire. In addition, the infant's productions were recorded during several natural play sessions with both a Norwegian speaker and an English speaker.

A lexical analysis determined the distribution of English and Norwegian words in the infant's lexicon and how these words were used in English and Norwegian speaking contexts. A nonlinear phonological analysis determined the infant's phonetic inventories, syllabic structure, and sound substitution patterns when he was speaking English and Norwegian words, and in English and Norwegian contexts.

Subject

The subject of study was a male infant, (A), age 1;2 to 1;11.12 for the total study, and between 1;8.17 and 1;8.26 for the phonological analysis. A is the only child of a Norwegian mother and an English-speaking Canadian father. A was born in Canada, where he continues to reside. During the period of study, A's speech consisted of single-word utterances. He began to produce some two-word utterances just after the study ended.

Language Influence

Language input to A is differentiated on the basis of parental (and other caregiver) native language. A's mother speaks primarily Norwegian to her son, while his father speaks primarily English to him. A's mother comes from Oslo and considers herself to speak 'standard Norwegian'. Apart from the many known dialects of Norwegian, there are two types that claim the title of 'standard Norwegian': Bokmål Norwegian and Nynorsk. Bokmål "is predominant in urban usage in all parts of the country while Nynorsk has its strongholds in the rural areas of western and midland Norway (Haugen, 1984, p.20). A's mother speaks standard Bokmål Norwegian.

Neither parent adheres strictly to the one-parent one-language method of interaction (cf. Döpke, 1992). Each parent speaks to A primarily in his/her native language, but each also uses his/her secondary language. This frequently results in a mixing of the two languages during an interaction with A, but generally not within the same utterance. Typically a parent switches languages to stress a concept (e.g. *nei, no*) or when a communication breakdown occurs, but A's father has been observed to say an utterance in English and then immediately repeat it in English on a routine basis. The amount of mixing in parental input to A is difficult to determine. A's mother reports that she only speaks to A in English when they are in the presence of other English speakers, but I have observed some English words quite regularly in her discourse (e.g. *oh no, no*, as well as when giving directions).

In fact, A's mother uses several English words instead of their Norwegian synonyms. For example, *bunny* instead of *and* has become the name of a stuffed toy and is used in both language environments. Other English words, although not functioning as proper names, have also been modelled in both English and Norwegian environments (e.g. *duck, oh wow, choo choo*). Only one Norwegian word was observed to have this same transfer into the English environment (i.e. *babubabu*, which is A's production for *brannbil* 'fire-engine'). Since each of this set of words has developed the same target in both language environments, the words cannot be identified with one language or the other in the analysis.

While in Canada, the Norwegian input that A receives has been primarily via his mother and aunt (who is also a native speaker of Bokmål Norwegian, but a less standard variety. He receives English input from his father, grandparents, babysitter (he was at the latter approximately 32 hours per week from approximately age 0;6 up through the period of study), daycare, and landlords. However, at the time of the study it was difficult to determine the dominant language. A received English input from a greater variety of speakers, including his father, grandparents, babysitter and those in his community. Norwegian input on the other hand, came only from his mother and aunt. This type of exposure was the most typical (i.e. while in Canada), but A's Norwegian grandmother has visited several times, during which she has spent most of her time with A, and A did not attend daycare.

A has also had several trips to Norway, as follows: at age 11 weeks - for 2.5 weeks, 0;6.0 - for one month, 0;10.0 - for two weeks and 1;6 - for one month. The number of speakers and amount of exposure is then reversed, and A heard virtually only Norwegian during these periods in Norway (as well as when his maternal grandmother visited Canada). Because the recorded data collection occurred soon after a one-month visit to Norway (at 1;6), during which time A heard Norwegian almost all the time, it appeared that English and Norwegian were similarly influential on his system at that time.

Data Collection

Data was collected via diary entries, questionnaires, and audio recordings during natural play interactions.

Diary Sample

The parents kept a diary from when A was 1;2 until he was 1;8, which contained information regarding all new words A produced or demonstrated an understanding of, the language to which each word seemed to belong, and the context in which the word was used. The parents were given the following format to guide their diary entry:

Diary Sample Guide

Date day/ month/ year	new word = (E) English, (N) Norwegian	understood/ spoken (A's version)	talking with	context	gestures
	ball (E)	understood & said "ba"	Grandpa	playing with ball	
	throw (E)	understood & said "p-p-row" (lips smack together for the 'p' sound)	Paige	playing with ball	only says "throw" when he throws the ball

MacArthur Communicative Development Inventory

The MacArthur Communicative Development Inventory for Infants (1989) was also used to obtain information about A's language use and comprehension. The Inventory summarizes the words and phrases that understood and/or spoken, as well as the actions and gestures used (although the latter information was not used in the present study).

Separate inventories for each language were completed when A was 1;2, 1;6, and 1;8 by his mother (Norwegian) and his baby-sitter (English). During the interval between the collection of Inventory #2 (1;6) and Inventory #3 (1;8), A spent one month in Norway with his parents.

Audio Recording

All recordings were made in play-oriented or other natural sessions (e.g. meal time, reading, etc.). Data from the MacArthur Inventory at age 1;8 was used as a basis for language elicitation in both the Norwegian and

English sessions. The same referents were targeted in both languages in order to investigate partial differentiation at both lexical and phonological levels. Nontargeted productions were also recorded in both environments to supplement the language sample and be representative of A's production abilities at the time of recording.

Imitation tasks were not specifically used, although imitation was evident in all sessions. A's productions were not differentiated for analysis according to spontaneity or imitation. Guiding this decision was (1) the small sample size, (2) object/word familiarity[1] (Ingram, 1989,; Schwartz & Leonard, 1982; Schwartz, Leonard, Loeb & Swanson, 1986), and (3) recent research demonstrating no differences in production between imitated and spontaneous speech (Horsley, 1995).

The English data were recorded when A was 1;8.17, 1;8.20 and 1;8.25 by A's grandparents at their home, and by the babysitter in her home; both are environments in which the A is exposed to English. A's father was twice present and involved in the play with A during the English recordings.

A's mother recorded the Norwegian data at home when A was 1;8.24 and 1;8.26. Recorded interactions were between the infant and his mother. The author was not involved in the interaction in order to preserve the Norwegian-only quality of the environment.

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[1] According to Ingram (1989), children's perception and possibly production abilities are better in words they know than in unfamiliar ones.

Equipment

Recording was done with a Marantz PMD 430 tape recorder onto Fuji FR-II Super TYPE II [CrO_2 (HIGH)] POSITION•BIAS:CrO_2/EQ:70μs tapes. A Samson SR-2/ST-2/ECM 144 wireless microphone was attached to the person interacting with A (since he refused to wear the microphone). This procedure resulted in a variable distance between the infant and the microphone and, therefore, a variable quality of recording. The acoustics of the room and signal-to-noise ratio were not measured. Control measures were limited, involving only trying to prevent recording from occurring around appliances or other producers of excess noise, and asking for A to be as close to the microphone as possible. The presence of the tape recorder did not seem to interfere with or influence A. Aside from a momentary interest in the machine, A appeared to forget that recording was taking place and, therefore, a naturalistic interaction was assumed to have occurred.

The taped recordings were digitized into SoundWorks via a TASCAM tape recorder to the computer using a ProPort link. Sampling rate was at 16Hz and a mono channel was used. Use of the SoundWorks program enabled multiple playback of recordings for transcription, as well as the ability to restrict playback of the productions to specific pieces. The data was heard through Koss TD/75 headphones.

Data Analysis

Transcription

A portion of the audio recordings of A was independently transcribed by two individuals, including the author, using the IPA (International Phonetic Association, 1990). Points of disagreement were marked, and these utterances were transcribed a second time. Transcription difficulties occurred with a number of segments. IPA symbols that were the most similar to A's productions and diacritics were used.[2] These include productions that were close to [ʃ, ç, s, s̪] as well as [ʤ, ʧ tç]. It is postulated, that like most children, A is still developing tongue control and placement, so placement continues to vary. At age 1;8, A had a characteristic release from voiceless stops, a fair amount of aspiration combined with labialization. Finally, A used a low unrounded vowel that is neither /ʌ/, /ɑ/, nor /ɐ/ (cf. Hildegard; see Leopold, 1949). This production is possibly influenced both by developing tongue control and the fact that the Norwegian vowel system does not contrast these vowels phonologically.

Despite these unique productions, the final reliability between the independent transcriptions was greater than 95%. Following this check, I transcribed the remainder and majority of the recorded utterances, using the same IPA system. All productions inaudible due to noise or overlapped

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[2] The IPA segments were based on adult productions, and therefore the productions of infants and children are sometimes slightly different than the closest standard symbols.

speech, nonintelligible productions, or nonwords, and all productions I interpreted differently than the interlocutor did, were not transcribed. To qualify for transcription, an utterance had to be produced in a relatively clear voice, without overlap of either another speaker or background noise, and produced at an intensity level adequate for a reliable transcription to be made.

Many of A's productions were preceded by a neutral vowel; for example, *banan* 'banana' was produced [əmʌnæn], which I did not include in the representation of the word. One interpretation of this vowel is as the equivalent of (or a place holder for) the English article *a,* or the Norwegian gender specific articles *en* or *et*. Another possibility is that the [ə] is simply prevoicing of the initial consonant. This alternative is supported by (1) the vowel's lack of stress, and (2) the fact that a number of A's initial stops were prevoiced with a homorganic nasal. Interpretation of these productions as part of the word would have influenced both phonemic inventory and syllabic shape; it also would have meant complete nonmatching of these words at both the segmental and prosodic levels of production in the substitution analysis.

Category Composition

The recorded data from this study was separated into five categories. Categorization was based on the environment the production came from (i.e. the language of the conversational partner), and the language of the

production (i.e the intended target was either English or Norwegian). This categorization yielded four categories, two for each language environment. However, a categorizing procedure had to be used to assign membership of words that are only minimally different between the two languages.

Many Norwegian words differ by as little as one segment from the English word. For example, the standard pronunciation of the word ball is pronounced [bɑl] in English and [bal] in Norwegian. In order to establish which target A was attempting for this word and others like it, the phonemic features of his production were compared with the features of the target. The target production that shared the most features with A's production was coded as the language target.

A fifth category was created to include any productions for which the target language could not be determined. Lexical items that were used interchangeably in both environments were included in this category. Examples of such productions include the English form of *bunny,* which was used in both environments, as well as the Norwegian *mamma.*

Analysis of the categories differed based on the possibility of determining target productions for the categories. Phonetic inventory and syllabic structure analyses were obtainable for all five categories. However, match and substitution analysis was restricted to English words and Norwegian words, since only these two categories had determinable targets (refer to Table 2.1).

Table 2.1 - Category composition and analysis

	English environment	Norwegian environment	Both environments
All words	PI, SS		
All words		PI, SS	
English targets			PI, SS, SP
Norwegian targets			PI, SS, SP
Ambiguous targets			excluded

(Note: PI = Phonetic Inventory, SS = Syllabic Structure, SP = Substitution patterns)

Lexical Analysis

Although the present investigation focused on bilingual phonological acquisition, the child's lexical system was also analyzed The number of English and the number of Norwegian word types in the diary, MacArthur Inventory and recorded data (excluding ambiguous productions) were tabulated in order to examine the existence of a dominant language. In addition, percentage of English productions in the Norwegian environment and percentage of Norwegian words in the English environment were calculated in order to investigate whether A distinguished between the language requirements of his listeners (refer to Lanza, 1990; Vihman, 1985; Vihman, 1986).

Phonetic Inventory Analysis

Although initial phonetic transcription was fine, a broad phonetic transcription (without marked onset and offset) was used to create the

phonetic inventories. The resulting phonetic inventory for the four categories were compared with each other and with the standard phonemic inventories of English and Norwegian. SpeechApps software was used to compare consonant inventories according to word position (Word Initial, WI; Syllable Initial, SI; Syllable Final, SF; and Word Final, WF). Phonetic inventories were analysed rather than phonological because I did not want to assume that A was using the segments of his sound system(s) contrastively.

Canonical Structure Analysis

The SpeechApp program (Bernhardt and Cam, 1995) was also used to calculate the syllabic constructions used in each language and language environment. Analysis was qualitative and quantitative for both number of syllables and syllable shapes. Each segment was coded as either consonant (C) or vowel (V). Affricates were treated as single segments, as were diphthongs (C and V, respectively). Glottal stops and glides were classified as consonants. Glottal stops were not counted as consonants in syllable shapes (unless they appeared to be substituting for another target consonant), because [ʔ] is not phonologically contrastive in either Norwegian or English, and words than begin with vowels are often pronounced with an initial [ʔ] by both children and adults.

Substitution Analysis

All tokens from each category were chosen in order to determine how A uses his sound system to make contrasts. However substitution analysis was restricted to two of the five categories (English Words and Norwegian Words). Target pronunciations are required to analyse match and substitution patterns; the 'ambiguous' category as well as the English Environment and Norwegian Environment categories were excluded from analysis, since targets for all productions were unavailable. The Norwegian target pronunciations were productions by A's mother that I transcribed. The English targets were transcriptions of 'typical' English pronunciations.

Analysis was according to percentage match of phonemic segments according to word position as well as syllabic shape. Analysis was also done with regard to type of substitutions and type of match. Comparison was made between the two categories.

CHAPTER THREE
RESULTS

Lexical Analysis

Lexical data were collected from three sources: parental diary, the MacArthur Communicative Development Inventory (1989), and tape recorded sessions. Table 3.1 summarizes how the data were obtained.

As evident from the Table 3.1, there is a difference between the number of words reported to be in A's lexicon and the number of words recorded. There is also a difference between the word types reported on the Inventories and those recorded. The latter difference can be attributed to language growth, since the recording was made a month following the final

Table 3.1: Number of word types by A as reported by parental diary, the MacArthur Communicative Development Inventory (1989), and transcribed from recorded sessions.

	English	Norwegian
Diary Total	59	67
Inventory at - 1;2 years	10	15
1;6 years	23	24
1;8 years	50	69
Total	56	70
Recording transcriptions		
Word types/tokens in each environment	59/203*	49/180*
Word types/tokens per language	36/141*	27/76*
Total lexical inventory (word types)	125	126

* Totals include a group of 'ambiguous' words; that is, these words may be counted twice.

MacArthur Inventory. Due to these differences, neither data collection method alone represents a complete picture of A's lexicon, so all data were pooled. Combination of the diary, the Inventories and the recorded data gives a total number of 126 different English words and 127 Norwegian words. Although synonymous word production across the two languages was reported/recorded 22 times (e.g. *balloon-ballong, boat-båt),* identifying 'true' synonyms, (e.g. production of both the English and Norwegian labels for an object), was difficult due to the similarity between Norwegian and English. Many words in the two languages differ only slightly, often by a single phoneme (e.g. *milk-melk* [mɪlk]-[melk]*)*. It cannot be concluded whether A is differentiating production of these words or whether he is using a single production in both environments.

Diary Data

A's parents kept a diary when he was 1;5 until age 1;11 (refer to Appendix 1). A method of diary entry was provided and explained to the parents, as shown in Chapter two; however, actual diary entry was somewhat more informal, often lacking the identification of the person to whom A was speaking. Since most of the diary entries were marked as being either English or Norwegian words, classification followed parent report for the majority of instances. However, several entries were not marked for either language, while others were marked for both. Most of these

productions were included onto both the English vocabulary list and the Norwegian. In some instances the parent did not code the word according to language, but the description of the context clarified the target language. For example, *bade* is unmarked for language, but the accompanying description clarifies that this production was repeated (as opposed to spontaneous), indicating that the word is Norwegian-based and should not be classified under both languages.

During the six months that the diary was kept, data entries were made on 49 different days. Included were entries of 36 new English words, 49 new Norwegian words, and 23 words that were ambiguous and counted as belonging to both languages (see Table 1). In both languages the majority of productions were nouns. Three words were each entered twice. In the diary, six synonymous words were found between the two languages: *no-nei, down-ned, nice-deilig, balloon-ballong, corn-mais, nail-spiker.*[1] Of this set, *nice* and *deilig* were the only productions that were reported to be imitated; the others were spontaneously produced but the latter two pairs were not marked to indicate whether they were imitated or spontaneous.

MacArthur Communicative Development Inventory

The MacArthur Communicative Development Inventory (1989) was completed by A's mother (Norwegian and English) and babysitter (English)

[1] Of this set, several words were not recorded, but their absence would not have influenced the subsequent phonetic inventories.

three times during the period of study, when A was 1;2, 1;6 and 1;8. These data are summarized according to language. Appendix 2 shows the English data according to A's age, and Appendix 3 contains the Norwegian data. Vocabulary counts are shown in Table 1. Vocabulary in both languages grew during the data collection period. In each language, the Inventories also demonstrated evidence of language decay. On the English Inventories, six words that were reported in A's speech prior to age 1;8 were not reported at 1;8. In Norwegian three words that were previously used were not noted in at age 1;8. These differences may be due to an oversight during completion of the Inventories, but interpretation of the data as demonstrating a language decay agrees with the observation that A discontinued production of several words during the study period (as reported by parents and grandparents).

At age 1;8, A produced 15 words that were common to the Inventories of both English and Norwegian. Of the 25 "synonyms" seven words have only a slight phonemic difference between the English and Norwegian production: *baby-baby, ball-ball, fish-fisk, milk-melk, more-mer, up-opp, moo-mø.* Thirteen words have the same target in both languages: *mama, papa, fire-engine*[2], *meow, no, tee-tei* ('peek-a-boo'), *hi, uh oh, owie, Tammy, choo-choo, vroom, baa-baa.* Four words have distinctly separate productions (*flower-blomst, down-ned, truck-lastebil, juice-saft*). Once again,

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[2] A's production *"babu"* appears to stem from the Norwegian *brannbil*; however, *"babu"* is modelled in both language environments.

caution in interpretation of the Inventories as demonstrating "synonyms", or separate/distinct productions across language environments for the same referent, is required.

According to the Inventory, A's comprehension at the time of inventory collection exceeded production. Comparison of the three Inventories for each language showed a growth in comprehension over the data collection period. It is important to note that the MacArthur Communicative Development Inventory separates comprehension and production according to 'words understood but not spoken' and 'words spoken'. This means that interpretation of comprehension growth cannot be done on a linear fashion since the 'understood' list does not contain all lexical items that are understood but rather only those that are understood but not spoken. Once a word is spoken, it moved from the 'understood' list to the 'spoken' list. In order to calculate the number of words actually understood, it is necessary to add the number of words produced to the number of words 'understood'. The figures in the following discussion are based on this calculation.

At each sampling time more Norwegian words were understood than English. Norwegian comprehension was noted to progress from comprehension of 32 words at age 1;2, to 96 words at age 1;6 and 152 words at age 1;8. English comprehension grew from 34 to 88 to 100 words by age 1;8. In summary, at age 1;8, according to the MacArthur

Communicative Development Inventory, A understood 100 words, and spoke (and understood) 50 words in English. In Norwegian at age 1;8, he understood 152 words, and spoke (and understood) 69 words.

Recorded Data

Recorded data differed from reported data in that they allowed for A's productions to be organized according to language environment, (i.e. spoken either to an English speaker or a Norwegian speaker) and according to target language (i.e. either an English word or Norwegian word was attempted). Vocabulary counts are shown in Table 1. Comparison of the reported and recorded lexical items is presented in Appendix 4 and Appendix 5 (English and Norwegian, respectively).

In the English environment, A produced 203 tokens and 59 word types. Of these productions 28 word types were English (47%), 8 word types were Norwegian (14%), and 23 word types were ambiguous (39%) (i.e. could not be assigned a target language). In the Norwegian environment, A produced 180 tokens and 49 word types. He used 16 Norwegian words (33%), 11 English words, (22%), and 22 ambiguous words (45%).

It should be noted that these percentages were calculated with the inclusion of some initially ambiguous words. Following the procedure outlined in chapter two, the target language was assigned for several words

that differed minimally between the two languages (i.e. a segment substitution creates the word in the other language). With the exclusion of these words, the percentage of language use differs. For example, the only two unambiguously Norwegian words A produced in the English environment were: *ned* 'down' and *stige* 'ladder'. In the Norwegian environment A produced only five unambiguously English words: *truck, hot, button, man,* and *yes.*

In the recorded data 'true' synonymous productions were: *nice-deilig, grape-drue, down-ned, hot-varm, truck-lastebil, bird-fugl.* Only the latter pair did A spontaneously produce each word and produce the English word in the English Environment and the Norwegian word in the Norwegian Environment.

Phonetic Analysis

The phonetic inventories discussed here are based on transcriptions of recorded data collected by the mother (Norwegian) and grandmother (English). Transcriptions were made according to the International Phonetic Alphabet (1990). Productions of all tokens were analysed according to environment and language, resulting in the following categories: English words, Norwegian words, English environment, and Norwegian environment. Ambiguous words were left in the environment in which they were produced, but excluded from the two specific languages, since a single language source could not be determined.

In the phonological acquisition literature, many analyses code segments according to frequency of production.[3] In this study, due to the limited sample size and the age of the subject, segment differentiation will be simply on the basis of multiple vs. single productions of segments. Parentheses, in all instances of segment presentation, will indicate the presence of segments with only one occurrence in the transcript. All productions, rather than typical productions (see Ingram, 1989), in order to describe the large variability of A's productions. For example, A produced the word *cheese* seven different ways: [ʤɪʃ, kuʃ, dʏç, ʤʏç, tʰɪʃ, kʏʃ, ʤɪʧ].

Consonants

An inclusive inventory of consonants that A produced, regardless of environment, target, or word position, is presented in Table 3.2. Classification is according to place and manner of articulation., A varies both manner and place of articulation. There is also variation in the number of times he produced different segments (e.g. A produced [n] 130 times vs. [b] 5 times vs. [l] once). This is at least partly due to his multiple productions of some words. In terms of manner of articulation, the following classes were used (in descending order of frequency): plosive, nasal, fricative, affricate and approximant (glides). Rarely used, or emerging are the

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[3] For example, segments could be designated as marginal, emerging, developing, or established (see Bernhardt & Stoel-Gammon, 1994).

lateral approximants (liquid). In terms of place of articulation, bilabial, coronal, palatal, and glottal were most frequently used. A used labiodental, dental, retroflex, velar, and uvular places less frequently. A used both values of [voice], as well as the feature [+/-round]. The feature [+distributed] was noted only once (i.e. [ð]). A produced and used as substitutions (for both singleton consonants and clusters), [mj, bj, hj]. The former two clusters were typical of Norwegian clusters, whereas the latter cluster was atypical to both languages.

Table 3.2: Total phonetic inventory and number of productions of A's consonants regardless of language environment or target language.

	bi-labial	labio-dental	dental/ alveolar/ post-alveolar	retro-flex	palatal	velar	uvular	glottal
Plosive	p b 23 83		t d 9 36	(ɖ)* 1	(c) ɟ 1 4	k (g) 3 1	(q) 1	ʔ 102
Nasal	m 88		n 133		ɲ 3	(ŋ) 1		
Tap or Flap					(ɽ) 1			
Fricative¤		f v 8 5	ð s ʃ 2/15/18		ç 10			h 29
Approx-imant	w 8		ɹ 4		j 30			
Lateral Approx-imant			(l) 1					

*Parentheses indicate a single production of a segment.
¤ In addition to the specific fricative listed, A produced three segments with fricative quality for which place could not be determined.
Note that allophonic variation has not been displayed in the table (e.g. [pʰ] and [p'] have been classified as [p]; nor have affricates.

Comparison of Consonant Inventories

A phonetic inventory of A's consonant productions according to environment, language and word position is displayed in Table 3.3. Again, frequency of production of segments is not fully displayed. For instance, A used [m] 44 times in the Norwegian environment, 22 times in the English environment, 21 times in English words, and 18 times in Norwegian words. (The number of types and tokens varied across both languages and environments; refer to Table 3.1).

As shown in Table 3.3, the consonant inventories are qualitatively similar across language environments and target languages. Comparison of the inventory of English words with the English environment inventory, and between Norwegian words and the Norwegian environment revealed few differences. As mentioned previously, the majority of English words were produced in the English Environment, and the majority of Norwegian words in the Norwegian Environment. There were some exceptions. The phonetic segment [v], found in the Norwegian words inventory, came from *vot* 'wet', a Norwegian word produced in the English environment. Production of English words in the Norwegian Environment resulted in the movement of [l, q, w, g] from the Norwegian Environment inventory into the English words inventory.

Table 3.3: A's consonant inventories according to language environment, target language and word position.

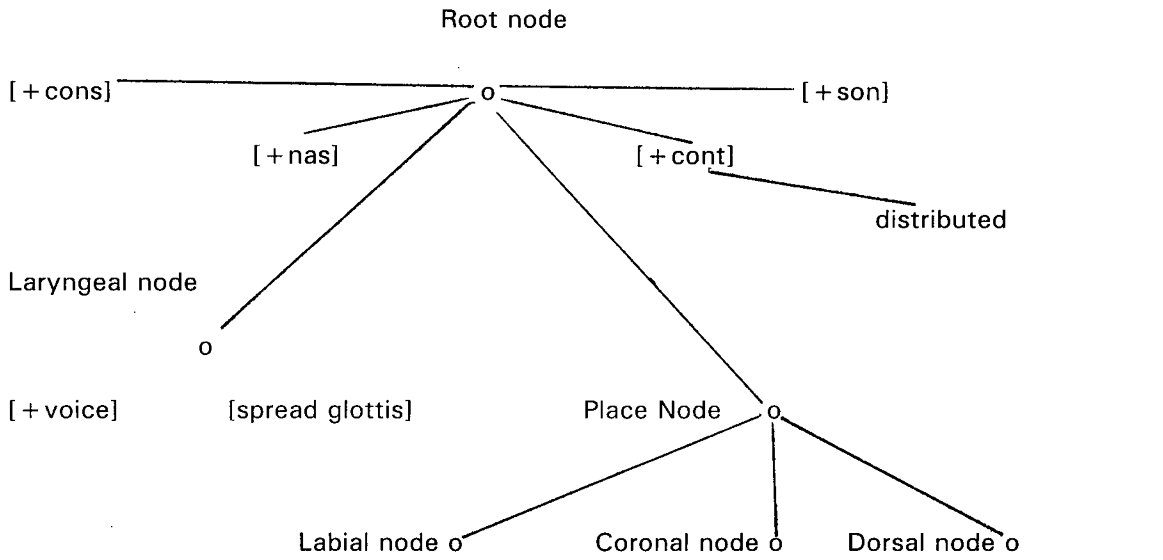
	WORD POSITION			
	Word Initial	Syllable Initial-WW *	Syllable Final-WW*	Word Final
ENGLISH WORDS				
Stops	b t d k (g) ʔ	d		p t d (c) q ʔ
Nasals	m n	(n)		n (ɲ)
Fricatives	f h			F f s ʃ ç
Affricates	ʤ			ʧ tç
Liquids	ɹ			(l)
Glides	w j	w (j)		
NORWEGIAN WORDS				
Stops	b t d (ɖ) ɟ ʔ	b d ɟ		(t) (d) ʔ
Nasals	m n	n (ɲ)		n
Fricatives	f v h	(s)		s ʃ
Affricates		(tç)		
Liquids	(ɹ) (ɽ)			
Glides	j	j		
ENGLISH ENVIRONMENT				
Stops	b t d k ʔ	b d (ʔ)		p (t) d (c) ʔ
Nasals	m n	m n		n (ɲ)
Fricatives	f v h	(v)		F f s ʃ ç
Affricates	ʧ ʤ	ʧ ʤ		ʧ tç
Liquids	ɹ			
Glides	w j	w (j)		
NORWEGIAN ENVIRONMENT				
Stops	p b (t) d (ɖ) ɟ (g) ʔ	b d ɟ (ʔ)	(d)	p t (d) (q) ʔ
Nasals	m n (ɲ)(ŋ)	m n (ɲ)	m	m n
Fricatives	f (v) (ð) h	(ð)(s) (ç)		s ʃ ç
Affricates	ʧ ʤ (tç)	ʧ ʤ tç	(tç)	(ts)
Liquids	(ɹ) (ɽ)			(l)
Glides	(w) j	j		

* WW = within word

Specific differences between the consonant inventories of the two language environments include the presence of [c] in the English environment, while [ð, ɖ, ɽ, ɟ] appeared only in the Norwegian environment. The fact that the retroflex consonants [ɖ,ɽ] were not produced in the English environment is suggestive of language separation, since they are members of the Norwegian but not the English system. Counter to this evidence is production of [ð] in the Norwegian environment, since it is found only in English. The weight of these three productions, [ð, ɖ, ɽ], is questionable, since A produced each segment a single time. The palatal fricative /ç/, also exclusive to Norwegian sound system, occurred in productions in both environments, and in English words: *cheese* [kuç], [ʤʏç], [ʤɪç], *fish* [ʔʏç], *nice* [nʌiç], *yes* [jʌç]. Similarly, /w/, not a member of the Norwegian sound system, was produced in the Norwegian Environment, in the English word *truck* [wɑʔ] (all other productions of /w/ were in English words in the English Environment). A also produced consonants uncommon to both English and Norwegian: [ɽ, c, ɟ, q, s̻, tç, ts̻]. Other segments that differ in membership between the two languages were not found in the recordings.

Comparison of consonant production between English and Norwegian words was also done at the feature level. At this level, differences between the two languages are not apparent. Figure 3.1 displays the feature hierarchy governing A's productions in both English and Norwegian.

Figure 3.1: Feature geometry for A's consonant system in either English or Norwegian words.



Vowels

Figure 3.2 displays a summary of A's vowel productions. All vowel segments have been combined. Discussion of vowel production differentiated by language environment and language target will follow.

Figure 3.2: Total phonetic inventory of A's vowels regardless of language environment or target language

i					u
ɪʏ				ʊ	
e (e:)* ø (ø:)	(ə)	(θ)		ɤ	o o:
ɛ ɛ: œ				ʌ ʌ:	ɔ ɔ:
æ	ɐ			ɑ	ɒ
a					

* Parenthesis indicate single production of a segment; length is indicated since it is phonemically contrastive in Norwegian.
Note: diacritics such as aspiration are not shown.

As shown in Figure 3.2, A produced a variety of vowels, varying height, backness, rounding, tenseness, and length. Monothongs constituted 82% and diphthongs 18% of his 546 vowel productions. Front unrounded vowels were more frequent in A's speech than back unrounded (157 vs. 128, respectively), and both types occurred more often than either front rounded vowels or back rounded vowels (103 and 45). A's most common vowel , [ʌ], comprised 18% of vowel productions; other frequent vowels, descending in order from 8% to 4%, were [i, ɪ, ɛ, ɔ, ɑ, o, ɤ]. The most frequent diphthongs were [ɔʊ] and [ɪu] (23% and 11%, respectively).

Comparison of Vowel Inventories

Classification according to different environments and language targets is shown in Figure 3.3. Differences between the categories appear minimal and largely due to sample size.

Figure 3.3 : A's vowel inventories

Vowel Inventory
English Words i ɪ ʏ ʊ (ø) o (oː) (ə) ɛ œ ʌ ɔ a ɑ ɒ
Norwegian Words i (iː) (eː) ɪ ʏ ø (ɤ) (o) ɛ œ (θ) ʌ (ʌː) ɔ æ ɐ a ɑ ɒ
English Environment i (iː) u ɪ ʏ ʊ e ø ɤ o (oː) (ə) ɛ œ ʌ ɔ (ɔː) a ɑ ɒ
Norwegian Environment i (iː) (y) u ɪ ʏ (ʊ) (eː) ø (øː) (ɤ) o (oː) ɛ ɛː œ ʌ ʌː ɔ ɔː æ ɐ a ɑ ɒ

Differences between the total inventory and individual inventories, separated according to language environment and target language, also appear minimal qualitatively. Once again, inventory size makes comparison difficult. For this reason, vowel frequency percentages will be contrasted (refer to Table 3.4).

The most frequently produced vowel in A's speech, in all inventories, was the back, unrounded vowel [ʌ]. The segments [ɪ, ɔ] were also frequent in all inventories. The English environment did not have [ɛ] as one of its most frequent vowels, and also differed by having [ʏ], a Norwegian vowel, in the top five. Despite these differences, the English environment most closely resembles the vowel frequencies found for A's total productions.

Table 3.4: A's five most frequently produced vowels in descending order (left to right)

Total	ʌ	i	ɪ	ɛ	ɔ
English environment	ʌ	i	ɪ	ɔ	ʏ
Norwegian environment	ʌ	ɛ	æ	ɪ/ɔ	
English words	ʌ	ɪ	ɑ	ɔ	ɛ
Norwegian words	ʌ	ɪ	ɛ	ɑ/ɔ/æ	

English Words versus Norwegian Words

Qualitatively, the vowels produced in English words vs. those produced in Norwegian words differ with regard to nine segments. Only the vowel inventory from English words contains [o:[4], ə, ʊ]. On the other hand,

[4] Vowels have been distinguished on the basis of vowel length, not to presuppose that A is using such variation contrastively, but in order not to collapse a possible distinction due to the fact that the contrast is phonemic in the Norwegian language.

only the inventory from Norwegian words contains [e:, i:, ʌ:, æ, ɐ, ɵ, ʏ]. Twice as many diphthongs were produced in English as in Norwegian words

English Environment versus Norwegian Environment

Comparison of inventories according to language environment (i.e. to whom A was speaking) reveals eight differing segments. Only the English Environment contains [ə, e,], while only the Norwegian Environment contains [e:, ø:, ɛ:, ʌ:, æ, ɐ]. Lengthened vowels were noted exclusively in the Norwegian Environment; recall that in Norwegian, vowel length is contrastive phonemically. A produced Diphthongs almost twice as frequently in the English Environment as in the Norwegian Environment.

Canonical Structure

Syllabic structure was analysed from all the word tokens used for transcription. Word shapes and syllable types A produced are displayed in Table 3.5 (according to language environment, and target language).

A produced monosyllables (57%), disyllables (42%), and a single trisyllabic word shape (1%). The Norwegian Environment had the greatest variety of word shapes. The most frequent syllable shapes were CVC and CVCV. Consonant clusters were infrequent, typically reduced into a single consonant. The only syllable shape with a consonant cluster was CCV, produced once in the English Environment (*more* [mjɛ]) and once in the

Table 3.5: Word shapes and syllable structures produced by A in English and Norwegian words and in English and Norwegian environments.

		English Words	Norwegian Words	English Environ.	Norwegian Environ.
Word shapes (# types)					
total types		7	6	9	12
1 syllable		4	3	4	4
2 syllable		3	3	4	7
3 syllable		0	1	1	1
Syllable shapes (# tokens)					
total		141	76	203	180
one syllable	VC	22	6	19	7
	CV	14	13	22	37
	CVC	95	26	79	56
	CCV	1		1	1
two syllables	CVCV	5	19	49	52
	VCV		3	23	16
	VCVC	1		1	1
	VCCV				1
	CVCVC	2	8	7	6
	VCCVC				1
	CVCCV				1
three syllables	CVCVCV		1	2	1

Note: Two or more vowels produced sequentially within a syllable are shown as a single V. The only instance of a vowel sequence occurring across two syllables was *meow,* CV.VV, produced once in each language environment. [ʔ] has been treated as a consonant only in words in which it replaced a phonemic consonant, eg. [bʊʔ] for *boot.*

Norwegian Environment (*no* [hjɛ]). Contiguous consonants appeared in the Norwegian Environment: VCCVC- [ɑmʔʌm], *numnum;* CVCCV - [pidðæ], *pizza.*[5]

[5] The transcription for *ballong* did not receive transcriber consensus and was not included. It was transcribed as [bɛlbʌnɪ] and [bɛubʌnɪ], both maintaining trisyllabic quality, but the latter without a contiguous consonants.

Segment Production Matches and Substitutions

Analysis of percent match as well as substitution analysis was restricted to the Norwegian words and English words, since only these words had known targets.

Consonant Accuracy

Results of the consonant match and substitutions are summarized in Table 3.6.

Table 3.6: Comparison of consonant match between English and Norwegian words (across word positions)

	English Words	Norwegian Words
# types attempted	28	22
# types/tokens produced	26/255	21/148
# types/tokens used correctly	12/107	6/49
# types/tokens used as substitutions	25/124	19/73
# deletions	25	26
Overall accuracy (types/tokens)*	46%/42%	29%/33%

* Accuracy calculated including cluster matching. All clusters were inaccurately produced. Accuracy using only singleton consonants increases percentages to 67%/48% and 37.5%/37% (types/tokens of English and Norwegian respectively).
Note that all A's productions that differed in syllable shape from the target form were removed from consonant match calculations.

A attempted more English consonant types than Norwegian types, and produced a greater variety of English types (27 versus 20). A used fewer segments and was less accurate with consonant production in Norwegian than in English, at both the type and token level. A matched productions of [m,n,p,b,t,d,f,ʃ,l,j,h,w] in English words ([t, l] were matched once each). In Norwegian words he matched [m,n,b,v,j,h] (matching [v] once). Comparison of consonant accuracy also requires data regarding opportunity for consonant productions, i.e. phoneme representation in the adult target words. A did not attempt the English consonants /v, ʤ, θ, ð, ʒ, ŋ/, or the Norwegian phonemes /ŋ, ʃ, ʈ, ɖ, ɳ, ɭ/. A more detailed analysis of consonant accuracy follows, presented in relationship to word position.

Comparison of consonant accuracy between English and Norwegian words at the feature level reveals the following differences. In English words, A matched production of:

1) nasals [m, n]
2) plosive [p, b, t, d]
3) fricatives [f, ʃ, h]
4) glides [w, j]
5) liquids [l]
6) labials [m, p, b, w]
7) coronals [t, d, ʃ, j, l]

In Norwegian words, A matched:

1) nasals [m,n]
2) plosive [b]
3) fricative [v, h]
4) glide [j]
5) labials [m, b, b]
6) coronals [n, j]

Consonant Match Comparison by Word Position

Consonant accuracy varied not only according to segment, but also on the basis of word position. As shown in Table 3.7, A's consonant production of consonant type in English words is more accurate in all four word positions analysed. Direct comparison is difficult, since differences exist between the number of types and tokens attempted and produced. For instance, consonant accuracy in word-final position appears significantly different between the two languages (47% in English words versus 10% in Norwegian words). In English words, A matched production of a variety of consonants: [n, p, t, d, f, ʃ, l]; in Norwegian words he only matched [n]. Two factors reduce this between- language difference; (1) there were no Norwegian target words with /p, f, ʃ/ in word-final position, and (2) the matches of /t,d,l/ in English were infrequent, 1/14, 2/2 and 1/9, respectively.

There were also differences at syllable-initial-within-word position. A had 50% type accuracy in English versus 14% in Norwegian, yet his percentage match of tokens was almost equal. Contributing to this an uneven distribution of type and token productions. Twice as many tokens were attempted in Norwegian, and four times as many tokens were attempted in Norwegian than English words. Secondly, consonant matches consisted of 1/1 for [n] and 2/2 for [d] in English words, whereas in Norwegian, A matched only one type - [n] - but did so 12/16 times.

Table 3.7: Consonant match comparison by word position

	English words type/tokens	Norwegian Words type/tokens
Word-initial*		
attempted	15/117	14/66
accuracy	53%/50%	43%/38%
Word-final		
attempted	15/131	10/48
accuracy	47%/35%	10%/25%
Syllable-initial-within-word		
attempted	4/6	7/26
accuracy	50%/50%	14%/46%
Syllable-final-within-word		
attempted	2/2	4/8
accuracy	0%/0%	0%/0%

* Although [ʔ] is often produced in word-initial position preceding a vowel, it was not counted as an attempted target since [ʔ] is not phonemic in either language.

Categorization methods may have influenced language comparison. As described in Chapter two, many English and Norwegian words differ only minimally. For this reason, classification of A's production of these words as either English or Norwegian involved labelling each word as belonging to the language that had the closest match. A match was established with the target language that differed by the fewest features from A's production. This procedure allowed the ambiguous words to be included in the match

and substitution analysis and thus increased the sample size of each category. Interpreting the influence of such a categorization procedure is difficult. Initially it does appear to have skewed the data according to type and token. For example, *house*, produced [høʃ] [hʏʃ] in the Norwegian Environment was determined to be a Norwegian word, since Norwegian is the most similar to both productions (specifically the [+round] quality of the vowel). If this word had been excluded from the data, or categorized as an English word, the segment /ʃ/ would not be represented in the phonetic inventory for Norwegian words.

Consonant Substitution Patterns

A's consonant substitutions included making changes in place, manner, and voice, and modifying clusters. Due to the difference in sample sizes and segments between languages and across word positions, calculations have been done in percentages, rather than numerically, for comparative purposes. Differences are apparent in the percentage and type of substitutions A used among word position both within and across the two languages (refer to Table 3.8).

Table 3.8: Substitution comparison across word positions (percentages)

	English Words				Norwegian Words			
	WI	WF	SI	SF	WI	WF	SI	SF
Manner substitution	8	14	40		38	5	25	
Voice substitution	6	8			13	3	15	
Place substitution	16	29	60		20	11	60	
C insertion in V-initial words	13							
ʔ substitution	16	27			13	18		
Cluster substitution	2							
Cluster replacement	2							
Cluster reduction*	27	4			11	24		
Deletion	10	18		100	5	39		100

* No accurate cluster productions were observed in A's speech in either language. Percentage differences with regard to clusters does not imply greater accuracy, but rather the presence of a greater number of clusters.

Examples of the substitution types presented in Table 3.7 include:

(a) manner substitution (e.g. [hɑtç] *for hot*)
(b) voice substitution (e.g. [ʤɪʃ] for *cheese)*
(c) place substitution (e.g. [hʏʃ] for *fish*)
(d) consonant insertion in vowel-initial words (e.g. [hɔpʰ] for *up*)
(e) [ʔ] substitution (e.g. [bʊʔ] for *boot*)
(f) cluster substitution (i.e.. [bjɑq] for *truck*)
(g) cluster replacement (i.e. [mjɛ̃] for *more*)
(h) cluster reduction (e.g. [fɑujə] for *flower)*
(i) deletion (e.g. [bɔ] for *ball)*

Vowel accuracy

As for consonants, a comparison was made between the accuracy of A's vowel production in English and Norwegian words to adult targets (refer to Table 3.9). Vowel segments, like consonant segments, were more accurately produced in English words than in Norwegian words. In English words, A accurately matched (in descending order from 50% to 11%) [ʊ, ʌ, ɛ, ɑ, ɪ, i,ə].[6] Of the five types of diphthongs attempted, only [ai][7] matched an adult target. Accurately produced vowels in Norwegian words (ranging from 100% to 12.5%) were [ø, ʌ, ɔ, i, ɛ, ɑ, œ]. Three diphthong types were attempted; only the diphthong [ai] was matched.

Table 3.9: Comparison of A's vowel production accuracy in monothongs in English and Norwegian words.

	English Words	Norwegian Words
# types/tokens attempted	11/136	13/101
# types/tokens produced accurately	7/39	5/18
# types/tokens used as substitutions	30/100	23/83
Production accuracy	63%/29%	60%/29%

Note that a difference in vowel length between A's production and the target vowel was not counted as an error.

[6][ʊ] was produced/attempted only twice, therefore receiving a high degree of accuracy with only a single correct production. The vowel [ʌ] was produced correctly 18/39 times.

[7] Transcriptions [ai] and [ʌi] have been collapsed since the distinction between the two is not phonemic in English.

In terms of features, in English words A correctly used:

(1) [-back] [i, ɪ, ɛ]
(2) [+back] [ʊ, ʌ, ɑ]
(3) [+round] [ʊ]
(4) [+high] [i, ɪ, ʊ]
(5) [-high] [ɛ, ʌ, ɑ]
(6) [-tense] [ɪ, ɛ, ʊ]

In Norwegian words, A produced correct matches of:

(1) [-back] [i:, œ, ɛ]
(2) [+back] [ʌ, ɑ]
(3) [+round] [œ]
(4) [+high] [i:]
(5) [-high] [ɛ, œ, ʌ, ɑ]
(6) [-tense] [ɛ]

Vowel Substitution Patterns

A's vowel productions, like his consonant productions are highly variable. Vowel productions vary both across and within words. Table 3.10 displays A's vowel productions of monothongs in English; Table 3.11 displays vowel productions of monothongs in Norwegian. Productions of diphthongs are shown in Table 3.12 and Table 3.13 (English and Norwegian, respectively).

Table 3.10: A's Vowel substitution patterns in monothongs in English words

		Monothongs Attempted										
		i	ɪ	ɛ	æ	u	ʊ	ɔ	ʌ	ɑ	ə	ɚ
P	i	1	1									
R	ɪ	3	9								2	
O	ɛ		1	3	1			3				
D	æ											
U	a			1					5	1		
C	ɤ	3	6									
E	ø		1									
D	œ		2						2		1	
	u	1										
	ʊ					1	1					
	o							2		2		
	ɔ								4	5		
	ʌ			2			1	2	18	2		
	ɒ								3	4		
	ɑ			1					6	6		
	ə										1	1
	ɐ								1	1		
	del	1									5	
	diph		7		3			3		5	1	

Table 3.11: A's vowel substitution patterns in monothongs in Norwegian words

		Monothongs Attempted												
		i	i:	ɪ	ɛ	y:	ø:	œ	o:	ɔ	ɔ:	ʌ	ɑ	ɑ:
	i		3	1										
	i:		1											
	ɪ	3	3		5									1
	e:	1												
	ɛ	1			7			1				1		3
	æ													3
P	a												2	
R	ʏ					2								
O	ø					1	1					1	1	
D	œ				1			1						
U	u													
C	ʏ	1												
E	ʊ													
D	o										1			
	ɔ										5			
	ʌ	2			4			4	1		1	7	6	
	ɒ									1		1	1	
	ɑ									2			2	1
	ə													
	ɐ													
	del.				5									
	diph.				1	6		1			1	1		

Table 3.12: A's diphthong substitution patterns in English words

	Diphthongs Attempted				
	aɪ	ʌɪ	aʊ	oʊ	eɪ
ai	1				
ʌi		2			
ɑu			1		
ʌo			1		
ʌɔ				1	
ɛ		3			
a			1		
ɔ				1	
ʏ					1

Table 3.13: A's diphthong substitution patterns in Norwegian words

	Diphthongs Attempted		
	ai	ʌi	iɛ
ʌɪ	1		
ʌi	1		
ʌ	1		1
æ		1	
ɛɪ		1	
a			1

A's vowel substitutions, although frequent, tended to be relatively close to their target in terms of place, tense/lax, and rounding.

(1) In English A's most frequent substitution was replacing a monothong with a diphthong, while in Norwegian his most frequent substitution was to replace the vowel with [ʌ].

(2) Front rounded vowels were more frequently used as vowel substitutions in English words than in Norwegian words.

(3) In both languages, A used front vowels more than back vowels as substitutions; however, in English words, he attempted more back vowels than front vowels.

(4) Round vowels were more predominant in English words than in Norwegian words.

Syllable Structure Shape Match & Substitutions

A produced a variety of word and syllable shapes in both English and Norwegian words (refer to Table 3.14 and Table 3.15, respectively).

Table 3.14: English syllable shape substitution

	Syllable Shapes Attempted									
	cvc	vc	ccv	cvcc	cvcv	cvcvc	cvccv	vccvc	vcvcc	ccvcvc
vc	6	16							1	
cv	14									
cvc	42	5	5	2		4			1	
ʔvc	10					1				
cvʔ	3		10	10						
ccv										
vcvc									1	
cvcv					1		1			1
cvʔv			1							
cvcvc								1	1	

Note [ʔ] was only counted as a substitution when it replaced a phonemic target segment.

Table 3.15: Norwegian syllable shape substitution

	Syllable Shapes Attempted										
	cv	cvc	vc	ccv	cvcc	cvcv	cvcvc	ccvccvc	cvccv	ccvcv	cvccvcvc
cv	4	6				1					
ʔv		2									
cvc		7			7			1		4	
ʔvc			1		2	1					
cvʔ	1										
vcv						2	1				
ʔvcv							1				
cvcv		1		1		8		3	2	1	
cvcvc							8				
ʔvcvcv											1

Note [ʔ] was only counted as a substitution when it replaced a phonemic target segment.

A's word shape accuracy was higher in Norwegian words than English (45% types/42% tokens in Norwegian versus 30% types/43% tokens in English).

In English words syllable shape accuracy (type/token respectively) was:

(1) monosyllables: 100% and 98%,

(2) disyllables: 83% and 46%.

For Norwegian words, syllable shape accuracy for type/token was:

(1) monosyllables: 80% and 94%,

(2) disyllables: 100% and 79%.

A attempted one trisyllabic word in Norwegian; it was produced as a trisyllable but inaccurate word shape (*lastebil* - cvc.cv.cvc became cv.cv.cv).

A also attempted a five-syllable Norwegian word, *papekokeman* - cv.cv.cv.cv.cvc, which he produced as cv.cv.

Once again, differences in A's accuracy with syllable and word shapes seem mainly due to differences in the number of tokens attempted.

CHAPTER FOUR
DISCUSSION

Overview

The present study investigated the simultaneous acquisition of Norwegian and English of an infant (A) at age 1;9, in order to investigate whether he used a single or a dual phonological system. Analysis focused on differences and similarities between phonetic inventories, syllabic shapes, and accuracy and substitution patterns as a function of A's language environment and target language.

Lexical System(s)

A's lexical inventory at age 1;9 included approximately 126 English words and 127 Norwegian words.[1] Interestingly, A had few two-word combinations. One possibility is that this was due to the play situation of the recording, which may have been predisposed to single word productions, like naming, especially with the babysitter who frequently A to name objects. However, family members reported that this was typical of his speech at the time. Previous research has demonstrated a wide range of expected vocabulary size at the time of word combination, but researchers have commented on their bilingual subjects having large lexical inventories and late word combination. For example, Vihman (1985) reports that her subject

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[1] The total inventory was gathered by compiling data from the parental diary, MacArthur Communicative Development Inventory (1989), and recordings.

began to combine words at 1;8 when he had a combined lexicon of 158 words. Similarly, at 1;9, A had just begun to combine words with a combined lexicon of approximately 139 words.

Cross-Language Synonym Production

An analysis of A's cross-language synonyms was done in order to investigate whether a lack of synonyms across the two languages is necessarily associated with language mixing (Volterra and Taeschner, 1978). Although there are indications that A produced cross-language synonyms, much of this data is from parental report (i.e. the diary or MacArthur Inventory). This data is not phonetically transcribed, so it cannot be determined whether A's productions were truly distinct between the two languages or whether his productions were the same in both environments. Of the recorded data, many possibly synonymous productions are not determinable (e.g. *baby-baby, ball-ball, boat-båt, more-mer, up-opp),* since the variability in A's production (between and across words) made identification of the target word unreliable. Of the synonymous words identified in the recorded data, only a single pair, *bird-fugl,* involved spontaneous production of both words as well as production of the English word in the English environment and the Norwegian word in the Norwegian environment. In fact, for transcription purposes, these words were assigned as either English or Norwegian (according to the procedure outlined in

chapter two) and were not treated as synonymous productions. Due to these difficulties, measurement of A's cross-language synonyms did not prove to be a reliable measure of language differentiation.

Effect of Environment on Language Choice

A more accurate measure of A's ability to differentiate between English and Norwegian at the lexical level was his distribution of English and Norwegian words in the two language environments. Although A produced English words in the Norwegian environment, and vice versa, he produced more English than Norwegian words in the English environment (47% versus 15%) and more Norwegian than English words in Norwegian environment (33% versus 22%). These totals also include 'assigned words', as defined in chapter two, so percentages would favour differentiation even more if assigned words were excluded from the total (39% of the words in English environment were ambiguous, and 45% of the words in Norwegian environment were ambiguous). Based on these results, it appears that A is taking the language of the listener into account. This would indicate awareness of the two languages--language differentiation at the lexical level--whether or not his own representation is single or dual.

Phonetic System(s)

Consonants

Consonant Production

Comparison of A's consonant productions did not reveal significant differences between language environments or target languages. A produced segments from both languages and segments that do not occur in either. Due to the limited sample size it is possible that some of his productions may have been errors/misarticulations or experimentations, while the frequency of others suggests that they are members of his phonetic inventory.[2] Conclusions are therefore tentative, but suggestive of a single system governing consonant production.

From a universal perspective, it was noted that A had production distinctions between consonant-vowel, vowel-vowel, nasal-oral and labial-alveolar. A's more infrequent productions were fricatives, laterals, retroflex, and velars. These results are consistent with predicted contrasts; however, the phonetic data from this study cannot be used to determine the order of acquisition because they represent a single sampling period, and A had a fairly well developed phonetic inventory at the time of recording. Thus, the data cannot contribute specifics to Jakobson's predicted universal order.

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[2] Throughout this study, A's productions, both within and across words, were highly variable. Interpretation has therefore been at a phonetic level since I did not investigate whether A used the segments of his inventory in a contrastive manner.

A's production of consonants that are atypical of English and some that are atypical of Norwegian supports predictions of the specific-language perspective. For instance, the presence of /w/ is not expected in a Norwegian system. Similarly, retroflex consonants are not expected to be in most dialects of English, and the palatal fricative--a member of the Norwegian system--is not a phoneme of English. In the latter instance, it is more likely that A's production of [ç] is not reflective of cross-language influence. A used [ç] as a substitution for /s/, /z/ and /ʃ/. Since infant productions of /s/ often have a palatal influence, or bladed articulation, A's productions may be attributable to developing motor control rather than lack of differentiation (see Bush et al., 1973). Further evidence in support of this interpretation is Vanvik's (1971) report that /ç/ is acquired late in Norwegian, suggesting it would be unlikely for A to have acquired this segment phonologically at this stage in acquisition.

In several instances, a difference in A's use of consonants across language environments and target languages was noted. For instance, the English segment /w/ appeared only in English words (although once in the Norwegian environment). Similarly, the retroflex [ɖ, ɽ] were produced only in Norwegian words (each appearing only once). This distribution of segments is suggestive of language differentiation, but due to the limited sample size and limited frequency of the segments, the data cannot be viewed as conclusive. Also weakening the differentiation argument is the fact that

another segment that A should have kept distinct across language targets appeared in both English and Norwegian words (i.e. [ç]; the reader is reminded of the previous explanation with regard to developmental production of [ç]).

Unfortunately, additional evidence to indicate language differentiation on the basis of consonant distribution is not available. Other segments characteristic of only one of the languages are typically acquired late in both Norwegian and English and were not found in A's productions: retroflex (except for the two productions already noted), inter-dental fricatives, an alveolar versus dental place distinction, and /r/ vs. /ɹ/.

Consonant Accuracy and Substitution

Is differentiation between the two phonological systems apparent in terms of A's consonant accuracy and substitution patterns? Interestingly, A had more accurate consonant productions in English than in Norwegian words (46% versus 42 % of types, and 29% versus 33% of tokens). Specifically, more plosives and coronals were accurately produced in English words. This result is somewhat surprising, considering the similarities among consonant segments in the two languages. Factors that may have contributed to this result include: differing numbers of types and tokens attempted in the two languages, consonants missing from the target sample in each language, and limited sample size. A final possibility is that, since A

has received slightly more exposure to English than to Norwegian, this may have contributed to more accurate production of English consonants.

Summary

Analysis of A's consonant productions across language environments and target languages indicate that, at the segmental level, he was not differentiating between the two languages. At 1;9, he appeared to be using a single system that was influenced by both English and Norwegian.

Vowels

Vowel Production

Comparison of vowel productions across language environments and target languages indicated no significant differences. A appeared to be using a single vowel system for both English and Norwegian words. His vowel system showed evidence of influence from both systems. In particular, a Norwegian influence--front rounded vowels in English words--was noted. A's production of these vowels seemed to be context specific; in 12 of its 16 occurrences in English words, the front rounded vowels occurred in two words (*cheese* and *fish*), and was either preceded and/or followed by an affricate or fricative. The remaining four productions occurred in the presence of a labial. In Norwegian words, front rounded vowels were produced following labial consonants and prior to palatal fricatives. The only

exception, a single production of [ɖʏjɛ] for *drue* 'grape'. These data suggest the possibility of a consonant-vowel coarticulation effect. However, A does produce other segments in these environments, thus reducing the possibility of a consonant-vowel interaction. The presence of front-rounded vowels may be due to A's preference for labial productions.

Analysis was not done to determine if A used his vowels contrastively; vowel analysis, like consonant analysis, was done at a phonetic level.

Vowel Accuracy and Substitutions

No difference in total vowel accuracy was observed across the two languages. When vowel types were counted, A was accurate 63% in English words versus 60% in Norwegian words; token accuracy was 29% in both languages.[3] Accuracy of specific vowels across the languages was also similar. In English, the vowels [ʊ,ʌ,ɛ,ɪ,ɑ,i,ə] (in descending order) were accurate 50, 46, 43, 33, 23, 11, and 10% of productions, respectively. In Norwegian, the vowels [ø,ʌ,ɔ,i,ɛ,ɑ,œ,] were accurate 100, 64, 45, 31, 30, 15, and 12.5% of productions, respectively. A much greater number and variety of diphthongs were used as substitutions for vowels in English words than in Norwegian words.

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[3] Note that vowel length has not been counted as a criterion of accuracy, since phonetically there is also a distinction between tense and lax vowel production.

Summary

A's vowel production, like his consonant production, does not indicate a phonetic differentiation between the two languages. A used similar vowel types and had similar vowel accuracy in English and Norwegian..

Canonical Structure

Canonical Structures Production

A produced a variety of word and syllable shapes including monosyllables, disyllables, and a single trisyllable. Once again, the canonical structures produced in English and Norwegian words appear similar. Differences in canonical structures between the two languages seem to be due to sample size, and type:token differences, or might be better explained following further analysis. For instance, A did not produce any CV word shapes in Norwegian words, and the 17 CV tokens in English were from only two word types (*up* and *on*). This most likely underrepresents A's ability to use this syllable type, which occurs in both languages.

A produced three consonant clusters (all in word-initial position); two in the Norwegian environment ([hj] and [bj]) and one in the English environment (mj). The latter two clusters appeared in English words and contained Norwegian clusters. The former cluster ([hj]) appeared in an ambiguous word and is not a cluster found in Norwegian. Also to be noted is the fact that [mj] appeared in an assigned word (refer to chapter two for

procedures). Two related differences were noted: A produced more multisyllabic words in Norwegian; therefore, not unexpectedly, more contiguous consonants were found in Norwegian words.

Canonical Structure Accuracy and Substitution

A's accuracy of word shape also differed across the two languages. Norwegian word shapes were more accurately produced than English word shapes (45% versus 30% of types). In both languages A had a high degree of accuracy matching syllable shape types in monosyllables and disyllables. Although his accuracy of Norwegian syllable shapes (tokens) is higher in disyllables, there is once again a discrepancy between the number of tokens attempted in the two languages.

Summary

Initial differences noted in canonical structure production as well as match and substitution patterns are explained by sample size and type-token differences. More in-depth analysis reveals that A appears to be using a single system to govern the canonical structure of his productions.

Summary and Conclusion

A's context-sensitive use of lexical items indicates language differentiation at the lexical level. This conclusion is consistent with previous

research that demonstrates language differentiation in contextually different ways. This is particularly interesting because the present investigation found during the one-word stage of production, while previous research has described this phenomenon at the two-word stage (Genesee, 1989; Lanza, 1992; Döpke, 1992).

A's segmental production at this point in acquisition (age 1;9), does not demonstrate two separate sound systems. The 'mixing' of segments across his Norwegian and English words indicates language-specific influences on his production. Although there are instances of specific differences, A's production does not demonstrate a differential production of consonants, vowels or canonical structure overall. Differences between accuracy of consonant and vowel production is in agreement with the proposal that consonant and vowel systems act differently and independently of each other (see Bernhardt and Stemberger, in prep).

Limitations and Assumptions

Since this is a single-subject study, it must be assumed that the data will generalize to a certain degree to phonological acquisition by other bilingual infants and, thus, add to the present knowledge base regarding language acquisition. Every child is, of course, an individual, and variation has been well documented in the field of language acquisition. (In fact, considerable differences exist not only in a learner's phonological production,

but also in the phonological productions of fluent speakers.) Since individual variation must be accounted for when considering any generalizations (Hecht & Mulford, 1982), it is unlikely that all data of bilingual acquisition of phonology will be similar to that from the present study.

The sample size in this thesis research has been commented on extensively. A larger sample size is needed to support generalizations as well as confirm that the sample is truly representative of A's phonetic ability. As it is, the present study serves as a starting point for future research into the bilingual acquisition of English and Norwegian phonology.

Contributions and Further Areas of Research

The general conclusion of this study is that, at age 1;9, an infant acquiring English and Norwegian did not appear to differentiate his phonetic production in his two languages. Although generalizations on the basis of such a small study must be interpreted cautiously, due to the cumulative nature of research each case study allows for comparison and verification with other language acquisition studies. Thus, the present investigation serves to supplement the present literature on bilingual phonological acquisition.

As well as contributing to the existing literature and providing a data base for comparison of future investigation, the present study also contributes at a clinical level. Speech-language pathologists are often

required to make judgements about possible phonological disorder or delays for bilingual children. They must also design intervention programs and identify goals for children who do show a delay or disorder. Because bilingual phonological acquisition has been shown to be similar to monolingual acquisition, the speech-language pathologist can proceed on the basis of available information about monolingual phonological development.

Although I have found A's productions to be undifferentiated across English and Norwegian, it is possible that he is separating the two systems at an acoustic level. For this reason, I suggest that an informative area of further research would involve an instrumental analysis of A's phonological productions, specifically a comparison of the frequency distribution of his vowels in English versus Norwegian words. It would be particularly interesting to discover whether there is any evidence to support Haugen's (1969) claims about the relative position in the vowel space occupied by English and Norwegian vowels.

Another area of investigation that would supplement the present study would be an investigation of A's phonological system. I did not investigate whether A was using the segments of his inventory in a contrastive manner, and therefore, conclusions are limited to the phonetic level. Analysis of segmental production in terms of phonological contrasts would provide an additional means to measure whether A is differentiating segmental production in English and Norwegian.

Finally, a major frustration in this research was the lack of information about Norwegian infants' monolingual acquisition of phonology. There is a great need for such research to be undertaken and shared with the international community of child language scholars.

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Appendix 1

Parental diary entries of A's productions

Diary entries		
age & target attempted	Description of A's production	context
1;5		
no (E)		
bunny (E)		
horse (E)	has	when seeing a horse
banan (N)	baban	when seeing a banana
ballong (N)	babong	when seeing a balloon
bil (N)	bi	when seeing a car
baby (N + E)	beibi	when seeing a baby
ball (N + E)	ba	when seeing a ball
båt	ba	when seeing a boat
tante (N)	tate	when seeing a picture of tante Susanne
Susanne	nana	
melle/mer (N)	mi-mi	wanting milk or more of something
tegne (N)	dejne	when he wants to sit down and draw, or when he sees drawing on the wall
down (E)	dow	standing up on his chair and pointing down with his finger at the same time
Tammy	mimi	name
John	don	name - says his name when he sees him leave in the morning or when he wants to go upstairs to play with John
vou-vou (N)	vou-voff	when seeing a dog
hot (E)	ha	when food or stove is hot
1;5.27		
heis (N)	heis	when we were going out and A could press the button for the elevator

Diary entries		
1;5.29		
brød (N)	bor	in the kitchen with mama or bestemor and seeing or eating bread
ja	ja	when mama asks questions like "Do you want more food?"/ "Do you want tot play?"
1;6.01		
mer (N)	me	when demanding more of something, usually a cookie Also when he wants his other boot/shoe/or mitten
all done (E)	alldon	when something is empty or he has done eating
1;6.13		
opp (N)	opp	holding his arms up & and wanting to be lifted up
nei (N)	nei	sometimes says nei instead of no
lys (N)	lis	pointing to a lamp or lightswitch wanting to turn it on
fly (N)	jai	when seeing or hearing an airplane
orange (E)	orn	eating or seeing an orange
1;6.25		
psyj (N)	push	repeating after mama when putting on PJ
1;6.26		
tran(N)	dan	
jakke (N)	ja (ja)	when putting on his coat/jacket or when he wants me to put on my jacket
1;6.28		
buss (N)	bush	when he sees a bus
papegoye (N)	papey	repeating after mama when playing with his parrot
keys (E)	dis	when we're leaving the house and A carries the keys

Diary entries		
1;7.02		
hot (E)	hot	when he was served food that was hot
den (N)	den	when I ask "What do you want?" he'll point at what he wants (raisan bran) and say "den" (that)
1;7.05		
ned (N)	ne	when I ask "do you want up or down?" (opp eller ned) he'll repeat "ned"
det er deg (N)	dadej	pointing at a picture at himself or a drawing saying "det er deg" ("its you" since that's what I tell him when we look at pictures of him)
1;7.08		
vann (N)	bam	pointing at a puddle of water, or a cup of water
mail (E)	mea	when Tammy picks up mail
1;7.09		
doren (N)	dom	when we open the door
1;7.12		
lys (N)	lis	when we light candles A says 'lis'
måne (N)	man	pointing to the moon
1;7.14		
don't touch (E)	don tosh	repeated after me when I told him not to touch
bok (N)	bo	pointing to his books or when he wants us to read
1;7.24		
lan (E)	len	talking to other baby at Tammy's
orange juice (E)	djus om	at breakfast
mus (N)	mus	looking at a mouse

Diary entries		
1;7.28		
eple/apple	aba	pointing to a fruit basket wanting an apple
Ole Brum (N)	babum/bibum	when A wants me to read Winnie-the-Pooh
hadet (N)	hade	in addition to 'bye' when he hangs up the phone
krem/cream	bim	when he/I put on cream
1;7.29		
bye-bye	choo choo	when leaving Tammy after having watched a video with Thomas the Engine
1;8.0		
deilig (N)	daedi	repeating when asked whether something (bath, food, etc.) is deilig
1;8.02		
what (E)	bhat	repeating after Tammy when she says what
1;8.03		
melon (N)	moon	when he sees/wants melon
rosin/raisin	henne	pointing to the box of Raisin Bran
1;8.06		
pita	bida	after I gave him a piece of Pita bread
1;8.08		
bade	bade	when asked if he wanted a bade - he nodded his head and repeated "bade"
te/tea	tea	when we drink tea or he sees a tea bag
1;8.12		
Tisse	tisse	Repetition when in the bathroom

Diary entries		
1;8.13		
lokk/kak	dom	asks me to open the 'door' when he's in the tub and wants me to unscrew the cork on his/mine shampoo bottles
nice (E)	nice	repeating when asked to be nice
1;8.21		
okay (N?E)	Adej	repeated after me when I said ok you can watch Thomas
1;8.23		
pusse (N)	busje	when brushing teeth
1;8.24		
Bagel (E)	beide	when seeing/eating a bagel
1;8.26		
muffin (E)	musja	eating/seeing a muffin
Diesel (E)	Diesa	Diesel on Thomas the Tank Engine
1;9.06		
Nisse (N)	nissa	name for one of the seven dwarfs that we play with in the pool
1;9.12		
ert (N)	ert	when he was eating peas
watch (E)	watch/batch	when he wants us to watch
truck (E)	tuch	when playing with trucks or seeing trucks on the road
is (N)	iss	when we have ice cream

Diary entries		
1;9.14		
wash (E)	wash	when his hands are dirty
noise (E)	noise	when making a banging noise
water	wader	playing with water
bed (E)	bed	when he wants to play in our bed
1;9.20		
egg (N/E)	ed	when making Easter eggs
Kathy	daesy	calling Kathy who lives upstairs
1;9.24		
jente (N)	ete	the girl in the Gingerbread Man
1;9.26		
away (E)	way	& pushing his hand while saying away
perle (N)	paede	pointing at my pearl necklace
1;9.27		
hotdog (E)	hatta	when I told him we're going to the farm. Place to have hot dogs
1;10.0		
hockey	adi	when it's hockey on TV
Toad	toad	character from Wind in the Willows
Badger	badge	character from Wind in the Willows
Ratti	batti	character from Wind in the Willows
Moly	mola	character from Wind in the Willows
tree (E)	chi	pointing to trees
hammer (E/N) nail/spiker	ban-ban	pointing to nails or a hammer

Diary entries		
chip (E)	chip	potato chips
1;10.01		
hammer (N)	hammer	he got his own hammer
balloon (E)	barlun	when he got a balloon
button (E)	buttin	buttoning his pants
1;10.09		
våt	bat	when I got soaked
bike (E)	bite	when seeing a bike
vogna (N)	banna	his stroller/or a "camping vogn"
1;10.13		
big ball (E)	bid ba	when playing with his beach ball (big ball)
1;10.18		
Kærs kom horse (N/E)	"sjæse tom hois"	calling for Oliver to come and look at him ride his horse. He calls Oliver "Sjæsj" since that's what I call Oliver.
on (E)	on	when he wants to wear something or keep something on
1;10.22		
cookie (E)	duttie	pointing to the cookies
mais (N)	mais	when we're eating corn on the cob
corn	torn	
jordbaer (N)	abaerd	strawberries
blabaer	babaerd	blue berries

Diary entries		
1;10.28		
alley	alli	pointing to a picture of garbage truck which comes down the alley
1;11.01		
Mia (N)	mia	bestemor Mia
1;11.03		
kom (N)	tom	when calling for somebody to come
1;11.08		
kaffe (N)	tasse	when playing with the thermos we fill wit coffee
1;11.13		
grandpa (E)	paepae	calling John
1;11.12		
spoon (E)	poon	looking for a spoon to eat his jogurt

Appendix 2

MacArthur Communicative Development Inventories for spoken English

Age 1;2	Age 1;6	Age 1;8
		all gone
baa baa		
	baby	baby
ball	ball	ball
	balloon	balloon
banana	banana	banana
	boots	boots
	bunny	bunny
bye	bye bye	bye
	choo choo	choo choo
		daddy (papa)
		doll (bibi)
	down	down
	duck	duck
		firetruck
		fish
		flower
		grandma
		grandpa
		hammer
	hello	
	hi	hi
	hot	hot
juice	juice	juice
		keys
		light
		me

Age 1;2	Age 1;6	Age 1;8
	meow	meow
	milk	milk
mmm mmm		
mommy		mommy
		money
		moo
		more
no	no	no
		nose
		oh no
		on
	orange	orange
	ouch	
	owie/boo boo	owie/boo boo
		peekaboo
		please
		shh
	shoe	shoe
		Tammy
thankyou		
		telephone
		truck
		up
	vroom	vroom
		wash
		what
	woof woof	woof woof
wow		

Appendix 3

MacArthur Communicative Development Inventories for spoken Norwegian

Age 1;2	Age 1;6	Age 1;8
		airplane
	aunt	
	baa baa	baa baa
ball	ball	ball
balloon	balloon	balloon
banana	banana	banana
bath	bath	bath
bird	bird	
		book
		bread
		bus
		bye
	car	car
		cat
		cheese
		choo choo
		coat
		cookie
		cow
daddy	daddy	daddy
dog	dog	dog
		door
		down
	draw	draw
		firetruck
		fish
		flower

Age 1;2	Age 1;6	Age 1;8
		grr
		hair
	hi	hi
		horse
		house
		jacket
	juice	juice
		lamp
		light
		look
	meow	meow
	milk	milk
mommy	mommy	mommy
		moo
		moon
	more	more
		no
nose		
		out
		outside
		owie
		pajamas
		paper
peekaboo	peekaboo	peekaboo
		potty
		quack quack
		shh
		Tammy
		there

Age 1;2	Age 1;6	Age 1;8
		this
		train
		truck
uh oh	uh oh	uh oh
		up
	vrooma	vroom
		water
		wet
woof woof	woof woof	woof woof
		yes
		you
yum yum	yum yum	yum yum

Appendix 4

Summary of English lexical productions

( ) contain diary information that was not specified to one language specifically (therefore inserted to both) or specified to both languages.
[ ] contain words recorded but not transcribed due to poor quality of transcription.
{ } contain words with unknown translations originating from the MacArthur

ENGLISH Recorded Data English Environment	MacArthur Data (in capital letters)* Diary Data (in small letters)
[airplane]	
all done	all done
	ALL GONE
	alley
	apple
	away
	BAA BAA - Aug.25
	(bagel)
baby	(baby) BABY
	(Badger)
ball	ball BALL
	balloon BALLOON
banana	BANANA
	(bath)
	bed
	big ball
	bike
bird	
birdy	
boat	
boo boo	
boot	BOOTS
bread	
bunny	bunny BUNNY
button	button
	BYE

ENGLISH Recorded Data English Environment	MacArthur Data (in capital letters)* Diary Data (in small letters)
cheese	
chick	
	chip
choo choo	CHOO CHOO
cookie	cookie
	corn
	(cream)
dog	
doggie	
	DOLL = BABY
	diesel
done	
	don't touch
	down DOWN
down	
duck	DUCK
	(Egg)
fish	FISH
babubabu	
	FIRETRUCK
flower	FLOWER
[frog]	
	GRANDMA
	Grandpa GRANDPA
grape	
hammer	HAMMER
hand	
	HELLO - Dec. 15
	HI
	(hockey)

ENGLISH	
Recorded Data English Environment	MacArthur Data (in capital letters)* Diary Data (in small letters)
	horse
hot	hot HOT
	hotdog
	(Ian)
	(John)
	JUICE
	(Kathy)
[keys]	keys KEYS
	(Kjærs kom horse)
ladder	
	light
	MMM MMM - Aug.25
	mail
	MAMA
	ME
meow	MEOW
milk	MILK
	(Moly)
money	MONEY
	MOO
more	MORE
	muffin
	(nail)
nice	nice
no	no NO
	noise
nose	NOSE
oh no	OH NO
	(Ok)
on	on ON

ENGLISH	
Recorded Data English Environment	MacArthur Data (in capital letters)* Diary Data (in small letters)
orange	orange ORANGE
ow	
	OUCH - Dec. 15
	OWIE/BOO BOO
papa	PAPA
	(pee)
	PEEKABOO
	(pita)
	PLEASE
puppies (?)	
	(raisin)
	(Ratti)
sandwich	
	SHH
	SHOE
/jai/ = sit N	
	Spoon
stuck	
	(Susanne)
/mimi/	(Tammy) TAMMY
	(tea)
[/hai/ = telephone]	TELEPHONE
[that (?)]	
	THANK YOU - Aug. 25
	(Toad)
	tree
truck	truck TRUCK
up	UP
uh oh	
	VROOM

ENGLISH	
Recorded Data English Environment	MacArthur Data (in capital letters)* Diary Data (in small letters)
[wash]	wash WASH
	watch
	water
wet (?) & vot	
[what's that]	what WHAT
woof	WOOF WOOF
	WOW - Aug. 25
yeah	
yes	
yup	

* Data from all three MacArthur Inventories have been combined.

Appendix 5

Summary of Norwegian lexical productions

( ) contain diary information that was not specified to one language specifically (therefore inserted to both) or specified to both languages.
[ ] contain words recorded but not transcribed due to poor quality of transcription.
{ } contain words with unknown translations originating from the MacArthur.

NORWEGIAN		
Recorded Data	MacArthur Data (capital letters)* Diary Data (small letters)	Translation
	BAA BAA	
	(bade) BAD	bathe
	(Badger)	-proper name
	(bagel)	bagel
ball	(ball) BALL	ball
ballong	ballong BALLONG	balloon
banan	banan BANAN	banana
baby	baby	baby
båt	båt	boat
bil	bil BIL	car
bilde		picture
	blåbaer	blueberry
	BLOMST	flower
	bok BOK	book
babubabu	BRANNBIL	fire engine
	brød BRØD	bread
bønne		bean
bunny		bunny
buss	buss BUSS	bus
button		button
choo choo	CHOO CHOO or TOG	choo choo or train
	{COOKIE}	
[deg]	DEG	you

NORWEGIAN		
Recorded Data	MacArthur Data (capital letters)* Diary Data (small letters)	Translation
[den]	den/DENNE	this/that
[der]	DER	there
deilig	deilig	nice
	det er deg	it is you (himself in picture)
	doren DOREN	the door
drue		grape
duck		duck (N = and)
	(egg)	egg
eple	(eple)	apple
	ert	pea
	fisk	fish
[fly]	fly FLY	airplane
fugl	FUGL - Dec. 14	bird
	GRR	grr
	hadet HADET	'bye,s'long
	hammer	hammer
	HEI	hi, hello
	heis	elevator
hest	HEST	horse
[hette]		hat
	(hockey)	hockey
	vau vau HUND	dog
hus	HUS	house
	HÅR	hair
is	is	ice cream
ja	ja JA	yes
	jakke JAKKE	jacket/coat
	jente	girl

NORWEGIAN		
Recorded Data	MacArthur Data (capital letters)* Diary Data (small letters)	Translation
John	(John)	John
	jordbear	strawberry
	kaffe	coffee
	(Kathy)	Kathy
	{KEYS}	keys
	(Kærs kom horse)	sweetheart come look at the horse
	kom	come
kone		wife
	(krem)	cream
	LASTEBIL	truck
	lokk/kok	lid
	lys LYS	light/lamp
	mais	corn
mamma	MAMMA	mama
	måne MÅNE	moon
mann		man
melk	MELK	milk
	melon	melon
mer	mer MER	more
meow	{MEOW}	meow or cat
	Mia	Mia (grandma's name)
	(Moly)	- proper name
min		mine
	mus MUS	mouse
mø	MØ	moo
	ned NED	down
nei & no	nei NEI	no
	NESSE - Aug. 31	nose

NORWEGIAN Recorded Data MacArthur Data (capital letters)* Translation Diary Data (small letters)		
	Nisse	dwarf's name
num num		num num
	Ole Brum	Winnie-the-Pooh
opp	opp OPP	up
oh no		oh no
	{OUT}	out
	{OUTSIDE}	outside
ow	{OWIE}	ow
	PAPA	papa
	papegøye	parrot
	PAPIR	paper
	perle	pearl
	{PEEKABOO}	peekaboo
	(pita)	pita
pizza		pizza
[porche]		porche
meow	PUS	cat
	pusse	brush
	pysj PYJAMAS	pyjamas
pære		pear
	QUACK QUACK	quack quack
rev		fox
rosin		raisin
	SAFT	juice
	SE	look
	SHH	shh
stige		ladder
	(Susanne)	Susanne

NORWEGIAN Recorded Data	MacArthur Data (capital letters)* Diary Data (small letters)	Translation
	(Ratti)	-proper name
spise		eat
	(Tammy)	Tammy
truck	SØPPLEBIL +	garbage trucks +
	tante	aunt
	tegne	draw
	(tisse)	pee
	(Toad)	- proper name
choo choo	TOG	train
	tran	cod-liver oil
traktor		tractor
	UH OH	uh oh
	vann VANN	water
varm		hot
	våt VÅT	wet
	vogna	stroller or camper
	vau-vau VAU VAU	dog or woof woof
	{VROOM}	vroom
	{YUM YUM}	yum yum

* Data from all three MacArthur Inventories have been combined