SEGMENT INTERACTIONS IN AUTISM

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A thesis submitted to the
University of Tromsø
in partial fulfillment of the requirements for the degree of
Master of Philosophy

in

Theoretical Linguistics

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Spring 2010

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Symbols and abbreviations

[]	inserted speech
[∅]	no feature
[cl]	closed
[nas]	nasal
[o]	open
+O	voiced obstruent
∅	no phonological process
1st	first member of a cluster
2nd	second member of a cluster
AS	adult speech
BAC	backing
BLE	blending
C	consonant
CCL	coda cluster
CDV	coda devoicing
CLC	cluster creation
COA	coalescence
CSR	child surface representation
DEL	deletion
DET	determinate
DIM	diminutive
DIS	distortion
DN	denasalization
DV	devoicing
FOR	fortitioning
FRO	fronting
HEI	heightening
IMP	imperative
MCL	cluster across morpheme boundary

LEN	lengthening
LOC	locative
MCL	cluster across morpheme boundary
MET	metathesis
MOA	manner of assimilation
NAS	nasalization
O	obstruent
OCL	onset cluster
PhE	phonotactic environment
PhP	phonological process
PL	plural
POA	place of assimilation
POSS	possessive
S	sonorant
SCL	cluster across syllable boundary
SG	singular
SHO	shortening
SIM	simplification
SR	surface representation
SYLL	syllable
UR	underlying representation
URS	unreleased stop
VA	voicing assimilation
V	vowel
VOC	vocalization
WCL	cluster across word boundary
WFC	word-final coda
WIO	word-initial onset
WMO	word-medial onset

Table 1: Symbols and abbreviations

0 Abstract

The thesis presents preliminary findings of a project concerning segment interactions as found in the speech of six children diagnosed with autistic spectrum disorder. The purpose of this thesis is threefold:

(1) to provide an overview of linguistically, especially phonologically relevant findings in the autism literature,

(2) to contribute to the field of autistic phonology with the field work and research on phonological processes characteristic of subjects on the autistic spectrum and

(3) to capture relevant phonological processes that have been observed in autistic speech with the help of the Parallel Structures Model (Morén 2003a-b, 2006a-b, 2007a-c, Youssef 2007).

Ultimately, two of the observed phonological processes – nasal and voicing disturbances and related phenomena – as well as their prevalence rates are discussed.

1 Introduction

This thesis is part of a large-scale project, intended to explore segment interactions in autism. This work will primarily be of interest to researchers inquiring into disordered speech patterns and speech-language clinicians[1] working with autistic subjects. In subsequent stages of the project, I aim to describe segment alternations and coalescences found in autistic speech.

The study was designed to address the following topics. First, I attempt to describe those processes that can be generally observed in the speech samples. The second issue is how pervasive these processes are. By looking into the speech patterns of six autistic subjects, I assert that there are certain characteristics that can be observed. One of these features is *nasal disturbances* (described in Section 4.4), i.e. excessive nasal coalescence co-articulation of nasals and the surrounding segments and non-standard nasal place assimilation. The other feature is *voicing disturbances* (discussed in Section 5.2), i.e. devoicing in unexpected phonotactic environments and voicing assimilation that is distinct from that observed in Standard Hungarian (outlined in Section 5.3). Finally, this thesis describes these phonological patterns in autistic speech and investigates the following topics:

(1) the prevalence of nasal and voicing disturbances in every speaker's repertoire (inter speaker perspective) and

(2) the prevalence of these processes in the speech of each subject (intra speaker perspective)

The outline of the thesis is as follows: in Chapter 2, I will define autism spectrum disorder and introduce the idea of evaluating autism from a linguistic perspective. Section 2.1 clarifies crucial terminological issues in disordered language research that will arise throughout the thesis. Within Section 2.1, I will define nasal and voicing disturbances employed the terminology used in disordered phonology in Section 2.1.1. As a summary of previous work on the phonological features of autistic speech, Chapter 2.2 provides a synopsis of the major points of works relevant with respect to early vocalization patterns (Section 2.2.1), echolalia (Section 2.2.2) and phonological features of autism (Section 2.2.3).

1 Speech Language Therapist (UK) and Speech Language Pathologist (US) refer to professions that are concerned with treating disorders of speech and language (defined in Chapter 2.1)

Chapter 3 details the methodology that has been pursued in the thesis. Chapter 3.1 introduces relevant crucial information about the subjects who participated in the study. 3.1.1 contains information about the general linguistic abilities of two subjects. In the discussion of Standard Hungarian, I use both theoretical and empirical works (Siptár and Törkenczy 2000, Morén 2007a-c, Olaszy 2007). Methods of data collection in speech samples recorded and transcribed by me are presented in Section 3.2.1 using the transcription of the speech samples in the discussion of nasal and voicing disturbances of autistic speech (complete list in Section 8.1). For demonstrating segment interactions in Standard Hungarian, a consonant-consonant database for Standard Hungarian is introduced (Section 3.2.2).

In order to capture the phonological phenomena both in typical and autistic speech, I use the Parallel Structures Model of feature geometry (Morén 2003a-b, 2006a-b, 2007a-c, Youssef 2007). Feature geometry is found to be extremely helpful in identifying speech sound errors and, thus, facilitating necessary language intervention in a principled, theoretically well founded way (Chin and Dinnsen 1991, Owens et al 2006). A discussion of the motivation for using feature geometries in disordered phonology research is found in Section 3.3. This thesis utilizes the Parallel Structures Model in order to describe the phenomena related to nasal disturbances (the model is detailed in Chapter 3.4).

Chapter 4 and 5 discuss two sets of phenomena that are related to the two phonological features in autistic speech. Chapter 4 details processes involving nasals both in Standard Hungarian and in the speech of participants, while Chapter 5 describes processes involving obstruents. The two phonological processes that have proved to be the two most prominent characteristics of autistic speech, are as follows:

- nasal disturbances: excessive nasal place assimilation and nasal coalescence (Chapter 4)
- voicing disturbances: devoicing and atypical voicing assimilation (Chapter 5)

More specifically, I will present certain properties of nasals in section 4.1, then review nasal place assimilation and nasal coalescence in Standard Hungarian (sections 4.2 and 4.3). 4.4 describes the realization of nasals in autistic speech, singleton nasals in 4.4.1 and nasal-consonant clusters in 4.4.2.

Voicing assimilation for obstruents in Hungarian is described in 5.1. The autistic voicing patterns are listed in 5.2. Devoicing and voicing of obstruents in various phonotactic positions are covered in sections 5.2.1 and 5.2.2 respectively and devoicing due to voicing assimilation in 5.3.

Chapter 6 briefly discusses possible avenues for future research in this area and the conclusion for the overall thesis is given in Chapter 7. The Appendix contains the transcription of speech samples (8.1), the PSM segment inventories of Standard Hungarian (8.2) and additional segment inventories from the phonological literature in autism (section 8.3 – Wolk and Edwards 1993; Wolk and Giesen 2000; Cleland et al 2010).

2 Autism as a language disorder

Autism spectrum disorder (ASD) has been described as a pervasive developmental disability with a wide range of severity and involving multiple genes, thus affecting various linguistic and cognitive faculties to differing degrees (Prizant 1983; Wolk and Edwards 1993; Kjelgaard and Tager-Flusberg 2001). Throughout the thesis, I use the terms 'ASD' and 'autism' interchangeably, by taking autism in its broader sense to correspond to ASD, following what seems to be standard practice. Symptomatology of ASD includes three diagnostic features, strictly based on behaviour (generally known as Wing's triad):

(1) lack of social responsiveness

(2) compulsive, ritualistic behaviour, and

(3) impaired communication and language skills,

present before the age of 3.

Although described and defined as a separate syndrome already in the 40's (Kanner 1943; Kanner 1946; Kanner 1949), autism was not recognized as a mental disorder in the DSM until 1980 (The Diagnostic and Statistical Manual of Mental Disorders, i.e. the DSM, is published by the American Psychiatric Association, providing unified diagnostic criteria for mental disorders). In that and all subsequent editions, language and communication is one of the key domains in the description of ASD. The diagnostic criteria related to language are:

(3) impaired communication and language skills

(a) lack of or late development of language, without any attempt to compensate with gestures

(b) impairment in the ability to initiate or sustain a conversation, and

(c) stereotypical, repetitive, and idiosyncratic language.

As mentioned, inadequate communication is a defining characteristic of autism spectrum disorder. It is estimated that more than half of the autistic population never learn to use *verbal symbols* (defined in Chapter 2.1) as a means of conveying ideas (thus, fulfill criterion (3a)) (Wing and Ricks 1975). For those who achieve meaningful communication through language, inappropriate usage of verbal symbols may result in conversation deficits (3b) and, from a linguistic point of view, in ungrammatical speech (3c). Virtually every layer of grammar can be hindered by ASD; it seems to impair pragmatic, semantic, (morpho)syntactic and phonological operations as well.

Writing about segmental changes in ASD is a challenging task. The overwhelming majority of autism studies have been conducted on a psychiatric, psychological or educational basis; i.e without recourse to linguistic considerations, despite the aforementioned fact that ASD is also a disorder of language. Researchers have mainly relied on limited, though salient deviances in autistic speech: pronoun reversal, echolalia, jargon / idiosyncrasy / neologism in speech, aberrant prosody, articulation, or hyper-nasalization (Rutter 1965, Wing 1971, Shriberg et al 2001). As Rapin and Dunn (2003) have asserted, even with the inclusion of anecdotal evidence, the least covered area is phonology: hardly any literature is to be found concerning the phonological skills of autistic individuals. It is necessary to adopt a proper linguistic approach in order to evaluate the phonological skills of ASD subjects.

2.1 Definition of terms

Before exploring the particular language impediments autism may cause, it is vital to briefly disambiguate concepts such as *speech, language, communication, articulation / pronunciation* and *phonology*, due to the inconsistent manner of their use in the literature related to autism. Terminology is generally taken for granted, which easily leads to misuse and confusion. Nonetheless, it is not difficult to see the necessity for a clear and careful discrimination of these concepts when discussing language disorders.

For some of the definitions, Sheridan's (1972) and Wing and Ricks' (1975) concepts are chosen as a starting point. In Sheridan (1972), *speech* is defined as the use of structured vocalizations to express verbal symbols. *Verbal* is deployed for systematized languages with signs for letters or words, sign languages and alternative augmentation strategies included. *Symbol* is defined as “something that stands for, represents, or denotes something else, not by exact resemblance, but by vague suggestion or by some accidental or conventional relation” (Oxford Dictionary, 2000).

Language is considered to be a set of interconnected systems or principles underlying and governing speech comprehension and speech production. In parallel with speech and language, *articulation* / *pronunciation* are the production or realization of speech sounds, and *phonology* is the underlying system.

The area where conceptual clarification may be necessary is that of the previous experimental studies with ASD subjects. When discussing them, it was often unavoidable to modernize the original terminology. *Normal* in today's jargon is *typical*, while *(mentally) retarded*, *disabled*, *mentally challenged* and *subnormal* have all been replaced by *cognitively impaired* or, more frequently, *having a learning disability* instead. Generally, all these terms refer to the condition of sub-average intelligence, i.e. below-70 IQ. Finally, *atypical* is any behavior, pattern etc. that contrasts with the *typical* one. Instead of the slightly archaic expression of *(phonological) error;* the terms *phonological process*, *pattern* and *phenomenon* are employed interchangeably.

Some terms pertaining to disabilities have also been updated: *receptive dysphasia* (Wing 1971) is known as *Wernicke's aphasia* and *developmental expressive speech problems* (Wing and Ricks 1975) goes under the term *expressive language disorder*.

2.1.1 Classification of nasal and voicing disturbances

Disordered language research extensively builds on the notions of developmental and non-developmental processes. More specifically, in disordered phonology studies, a distinction between developmental and non-developmental phonological processes is generally presupposed (Stoel-Gammon and Dunn 1985, Edwards and Shriberg 1983, both cited by Wolk and Edwards 1993, Grunwell 1985, Todd and Iacano 1989, Wolk and Edwards 1993, Fee 1996, Bowen 1998, Bowen 2009, Cleland et al 2010). *Developmental processes* within phonology are those that are observed in the early stages of typical phoneme acquisition, while *non-developmental* ones are often indicative of a phonological disorder and trivially do not occur under typical conditions. The latter group tends to be more persistent, persevering well beyond the early language acquisition stages to adolescence and adulthood, if left untreated.

For example, developmental phonological processes include onset voicing and coda devoicing (discussed in Bowen 1998), as shown in Table 2.

Table 2: Chart of developmental voicing processes (Bowen 1998)

phonological process	example

context-sensitive voicing[2] (i.e. onset voicing)	/p/ig → /p̌/ig
context-sensitive devoicing[2] (i.e. coda devoicing)	re/d/ → re/d̥/

By applying the distinction between developmental and non-developmental phonological processes, onset devoicing is understood as a non-developmental process, since it does not occur in typical development. I regard this process to be devoicing even if it might be the case that the subject does not make a phonemic contrast between voiced and voiceless because I take the underlying representation of the phonemic form of the participants to be identical to the adult underlying representation (cf. Section 3.2).

The terminology of phonological processes is itself an assertion of the existence of the identical underlying representation. All phonological processes that are discussed in disordered phonology research, such as 'devoicing', 'voicing', 'fronting', 'backing', 'deletion', 'centralizing' etc. presuppose the existence of the ideal (i.e. the adult) form against which the the existing form is compared with.

As mentioned, non-developmental processes are not found in typical language acquisition and are thus defined by their absence from typical development. Among the processes that I am going to look into in Chapter 4 and 5, there are developmental as well as non-developmental ones. Nasal place assimilation and voicing assimilation are developmental, nasal coalescence and onset voicing are non-developmental in nature (because they are not found in typical child language).

On a related note, another classification protocol for phonological processes needs to be introduced. Ingram (1995) differentiates levels of simplification in the course of phonological acquisition (examples are given from the database containing the samples in 8.1). These levels include:

(1) segment structure simplification

e.g. fricative fronting: /ʃ/ → /s/*ajnálom* 'I'm sorry'

(2) assimilation processes

e.g. nasal place assimilation: *To/*mt͡ʃ/ → /n̄t͡ʃ/*i (*male name)

(3) syllable structure simplification

e.g. coda deletion: *tűz* → *tű* 'fire'

(4) prosodic structure simplification

e.g. unstressed syllable deletion: *má(sikat ad)d ide* → *mádide*

2 see the discussion below on Ingram's (1995) layers of simplification.

Bowen (1998) uses the distinction of context-insensitive and context-sensitive in terms of phonological processes (as Table 2 shows). Context-insensitive processes are those that take place regardless of the phonotactic environment (can be identified with segment structure simplification), while context-sensitive processes are those that are dependent on the phonotactic environment (largely equivalent to syllable structure simplification). However, within this distinction assimilation processes cannot be accommodated.

This thesis is concerned with processes that cannot be accommodated either the segment structure level or at the syllable structure level. The intermediate level defined by Ingram (1995) as a level for 'assimilation processes' is not sufficient to account for non-developmental phenomena such as nasal coalescence. Therefore, I will name it *segment interaction* level.

With all these in mind, the difference between voicing and devoicing phenomena and voicing assimilation can be highlighted. Developmental voicing and devoicing (i.e. onset voicing and coda devoicing, cf. Table 2) are syllable structure simplification processes, meaning that they take place in order to achieve an easily pronounceable syllable structure (Bowen 1998). Voicing assimilation, on the other hand, involves interaction between obstruents and always targets the first member of the obstruent cluster (see Section 5.1).

2.2 Literature overview

In the following sections, I will present former findings pertaining to sound development in autism.

2.2.1 Early vocalization patterns in autism

Autistic speech is hypothesized to be deviant from the very beginning of sound development. Ricks and Wing's (1975) experiments with vocalizations of typical (0;8-1;0), and ASD (3;0-5;11) children shed some light on the differences. Parents of typically developing infants could identify the conveyed meaning (proto-emotions like pleasant surprise or frustration) in all typical vocalizations, regardless of the infants' language environment, while parents of autistic children were only able to decipher the meaning of their own child's vocalizations, but not those of the others out of the ASD group.

Naturally, far-reaching conclusions should not be drawn solely from this experiment, partly because of the relatively small number of participants (10 typically developing and 27 autistic subjects), but these results could lead to two preliminary assumptions: first, that typical sound development may be very similar at the start, and second, that ASD sound development may be markedly deviant from the beginning. The signals of children with ASD do not hold common features with either the signals of typically developing children or with that of their autistic peers'. That means that the vocalization patterns for each autistic child are unique.

Another astonishing, though presumably limited, phenomenon that Wing and Ricks (1975) discussed is the children's reaction to the playback of their own babbling. Autistic subjects tend to imitate their vocalizations (but no vocalizations by others), a response that typically developing children and children with Down syndrome did not exhibit in the experiment of Wing and Ricks (1975). Thus, researchers might want to ask why own voice triggers echolalia exclusively for the autistic children.

Wing and Ricks (1975) were inclined to state that children with ASD, unlike typically developing children, are sensitive to the *pattern* and not to the content of speech. According to Wing and Ricks (1975), autistic subjects may be attuned to remember simple patterns better than meanings or context; this could, in turn, account for their preference to engage in repetitive activities. Their memory may be excellent within the domain of recurrent simple events, patterns, dates, but typically without a concomitant social context (the notion of weak central coherence in autism, e.g. Happé 1997). Therefore, it is imperative to test whether any general patterns in autistic phonological processes can be inferred.

2.2.2 Echolalia in autism

This section summarizes the characteristics of echolalic speech (i.e. imitated speech) in autism. Spontaneous speech is by definition generated by the individual, whereas echolalic speech is wholly or partially taken from previous speech experiences. A typical developmental course might also contain some echolalia; therefore, it is a developmental process (cf. distinction between developmental and non-developmental processes in Section 2.1), although, exhibiting echolalia beyond the age of 2;5 indicates a language disorder (Bowen 1998).

Rutter (1965) and Wing (1971) (cited by Wing and Ricks 1975) found that, on average, three-quarters of all utterances are echolalic in autistic speech. In extreme cases, echolalia is the primary means of verbal communication.

According to Kanner (1943), there is no size limit to echolalic chunks. Echolalic expressions can vary in size from just the final words of a phrase to a whole conversation. Echolalia can be immediate or delayed, can be preserved for years, and repeated in a stereotypical fashion.

Further, some children may engage in *meaningless echolalia;* being able to store the acoustic and (supra)segmental information and reproduce them in a seemingly random, unrelated context (the distinction between meaningful and meaningless echolalia is discussed in Wing and Ricks 1975). Alternatively, echolalia can also serve subtle communicative purposes for an autistic child. For example, the ASD subject may be able to use an expression in the appropriate context, but with only preserved, contextually ungrammatical pronouns[3] (e.g. saying 'Do you want a biscuit?' when they would like to have one). In meaningful echolalia, the question arises whether the child acknowledges words as symbols rather than as unanalyzed, ungeneralized concrete utterances.

Those subjects who at least partly employ spontaneous speech in their communicative repertoire use words as abstract entities. These might be far from the full-fledged concepts of a typical child or adult, since nuances and ambiguities often evade individuals with ASD; moreover, a one-to-one correspondence between words and denoted entities is strongly preferred in autism (Boucher 1988, Grandin 2006). Cognitive mechanisms supporting language acquisition such as classifying and establishing connections are also severely impaired in autism (for more on impaired classifying skills, cf. Boucher 1988). Wing and Ricks (1975) hypothesized language acquisition in ASD to be more a passive and rigid event undergone by a child, reminiscent of a computer storing data, than a creative processing and organising of experience. Grandin (2006) adds that generalization errors, for instance in the natural kind hierarchy (using “dog” for “animal” or “clothes” for “shoes”) a typically developing child quickly corrects, tend to be persistent in autistic speech.

3 Preservation of pronouns would suggest that the well-known phenomenon of pronoun reversal might be a product of echolalia.

The important difference to make between spontaneous and echolalic speech is that echolalic speech is generally more articulated, while spontaneous utterances consist of more distortion errors, regardless of developmental level or diagnosis (e.g. Wing and Ricks 1975). Therefore, studying autistic echolalic speech in addition to spontaneous utterances supplies the researcher with invaluable information concerning the current state of language development, since if a phonological process takes place in the more enunciated echolalic speech, that throws light on the present state of the phonological system. Studies such as Wolk and Giesen (2000) and Cleland et al (2010) have incorporated echolalia into their corpora (their findings are briefly touched upon in the following section). This thesis also includes imitated and elicited speech in the analysis, provided the utterance is delayed (listed with the spontaneous data in Section 8.1).

2.2.3 Phonological perspective in autism

Since Wolk and Edwards (1993) provides an excellent review of the studies, this section partly utilizes their outline. As mentioned earlier in this chapter, previous linguistic approaches towards autism have been primarily behavioristic, which can be seen in the concern for articulation rather than for phonology (e.g. Rutter 1965; Frith 1970; Shriberg et al 2001). What was previously classified as 'articulation disorder' before the 70's, became categorized as 'phonological' throughout the 80's and 90's. Illustration 5 depicts the gradual shift of attention to phonology, i.e. the underlying system behind speech sounds in speech-language disorder studies (Bowen 2009).

ARTICULATION	→	→	→	→	→	SPEECH
ONE COVER TERM	**TWO COVER TERMS**	**NO SPECIAL COVER TERM**	**OVERLAPPING COVER TERMS**	**ONE COVER TERM**	**ONE COVER TERM**	**ONE COVER TERM**
Articulation was the cover term as in 'functional articulation disorder'.	Children were seen to have an articulation difficulty OR a phonological difficulty, with the emphasis on articulation.	Articulation disorder and phonological disorder were used almost synonymously.	Children were seen to have a phonological difficulty OR an articulation difficulty, with the emphasis on phonology. There were frequent observations of overlap between them.	Child SSDs were referred to collectively by authors and clinicians in terms of delayed or disordered phonology, incorporating phonetic and phonemic levels.	The term was now expanded to incorporate Phonological Awareness, Memory and 'Phonological Production' (Shriberg, 2006), acknowledging the speech-literacy link.	From about 2005 SSD became prominent as the preferred cover term.
ARTICULATION	**ARTICULATION & PHONOLOGY**	**ARTICULATION or PHONOLOGY**	**ARTICULATION-PHONOLOGY**	**PHONOLOGY**	**PHONOLOGY**	**SPEECH SOUND DISORDERS**
1920→1970	**1970→1980**		**1980→1990**		**1990→2004**	**2005 →**

Illustration 1: From articulation disorder to speech sound disorder (taken from Bowen 2009)

Articulation measurement in autism by standardized articulation tests has been initiated by Boucher (1976) and continued in subsequent years (Bartolucci et al 1976; Bartolucci et al 1977; Tager-Flusberg 1981; Boucher 1988). These researchers emphasized the prevalence of 'articulation distortion errors' in ASD compared to typical speech as well as the speech of subjects with pervasive developmental delays and learning disability. Wing (1971) concluded that 'pronunciation' is more affected in ASD than in Wernicke's aphasia.

In a similar fashion, Shriberg et al (2001) found qualitative differences between the articulation and prosody of children with high-functioning autism and Asperger syndrome, controlled by typical, chronological age - matched children. According to Kjelgaard and Tager-Flusberg's (2001) findings gained by the Goldman-Fristoe expressive phonology test[4], articulation skills across all autistic children are significantly below age expectations. However, it is to be noted that autistic subjects are far from being a linguistically homogeneous group.

Therefore, although studies have indicated the presence of articulation deficits in autism, only a limited number of empirical researchers have tried to accommodate their findings in extensive phonological analyses. Phonological patterns of autistic subjects are rarely described. Lack of research

4 The Goldman-Fristoe test gives information about articulation ability by sampling both spontaneous and imitative sound production. It is primarily used to measure articulation of consonant sounds and determine types of misarticulation (Pearson Assessment and Information).

could be due to inherent difficulties in data collection, for the very same reasons that have been listed as defining features of language in autism (3 a-c). Another argument was given by Lord et al (1997) and Kjelgaard and Tager-Flusberg (2001). While considering the linguistic abilities of autistic individuals, they pointed out the ultimate diversity of the autistic population in terms of ”vocabulary, grammatical [i. e. syntactic] knowledge and articulation skills” (Kjelgaard and Tager-Flusberg 2001).

In nonsense-word repetition tests, autistic subjects performed significantly worse than control groups, while in a vocabulary measure (Peabody Picture Vocabulary Test[5]) they produced approximately identical, but still slightly below average results. Kjelgaard and Tager-Flusberg (2001) resolved the asymmetry by claiming that nonsense word repetition does not require rote memory skills, unlike word elicitation. On the one hand, this asymmetry could be caused by spared phonological working memory (since Gathercole and Baddeley 1990 hypothesized this to be the leading cause of disordered language development).

On the other hand, Kjelgaard and Tager-Flusberg (2001) asserts that relatively non-impaired rote-learning skills in autism, are able to compensate, to some extent, for working memory deficiency in learning (even to overcompensate in the case of hyperlexic[6] children). On a related note, Boucher (1988) pursued the possibility of autistic word generation deficits due to poor semantic knowledge of abstract concepts like words (and other phonological entities, segments, syllables), rooted in poor central coherence (Happé 1997).

From the restricted knowledge base available, some researchers have arrived at the conclusion that autistic linguistic development does not appear to be strikingly different from typical acquisition (Rapin and Dunn 2003) or the development of children with learning disabilities (e.g. Paul 1987). Bartolucci et al (1976) found that autistic phonological development generally shows the same landmarks as typical acquisition, although in a slightly delayed fashion. Wing and Ricks (1975) drew a parallel between autism and expressive language disorder.

A more fine-grained approach was adopted by Tager-Flusberg (1981). Besides noting that phonological development in autism seems to follow the typical course, she also pointed out that phonology (especially suprasegmental phonology) and syntax in ASD are more or less preserved and

5 PPVT is a standardized multiple choice test measuring an individual's receptive vocabulary and verbal ability (Pearson Assessment and Information).

6 Hyperlexia refers to a condition with unusually advanced reading skills, in sharp contrast to communication and language abilities. 5-10% of the autistic population is estimated to be hyperlexic (Burd and Kerbeshian (1985), cited by Jensen 2005).

that the problem is usually posed more by semantic and pragmatic acquisition.

Clinical reports cited by Shriberg et al (2001) noted that the perception of suprasegmental features, such as stress, pitch, rhythm and intonation are often found impaired. Monotonous and flaccid voice quality appears to be a feature of ASD speech. Other controlled studies, however, seem to contradict these observations. Cooper and Curcio (1981) found that higher functioning autistic children do modify intonation even in echolalic utterances, the level of which appears to correlate with the overall state of language development.

The tendency in other studies is that distinguishing marks for autistic language exist. Bartak et al (1975) described autistic speech as being disproportionately delayed, containing “transient immature pronunciation patterns”. Bartolucci et al (1976) demonstrated that phoneme frequency distribution and the distribution of phonological process types in autistic subjects can be contrasted to both the results of typical and cognitively impaired individuals; in other words: autistic subjects tend to use different phoneme substitution strategies from non-ASD peer controls. Bartolucci et al (1977) also observed the impairment of both perception and production for fricatives, nasals and liquids, in comparison with the sound perception and production of typically developing and cognitively impaired individuals, besides the overall delay in autistic sound development.

These data warrant a new line of investigation, which treats autism as a specific language disorder. Rapin and Dunn (2003) envisioned a new role for phonology in the study of language disorders, since they found imperfect phonological parsing to be a powerful precursor for delayed syntax and lexicon acquisition.

Wolk and Edwards (1993) may be correct in pointing out that previous studies fail to provide a systematic evaluation of linguistic abilities in autism. It could be partly due to setting non-theoretical goals (investigations limited to articulation skills and vocabulary), predominance of laboratory-environments, and a small (perhaps non-representative) sample of participants (for example, Kjelgaard and Tager-Flusberg's (2001) pre-selection of participants in favor of deficits in language comprehension).

The phonologically relevant illustrations of the following three studies are listed in the Appendix section. Wolk and Edwards (1993), Wolk and Giesen (2000) and Cleland et al (2010) are studies that include truly phonological considerations in examining ASD speech. All of them found that both voicing and nasalization capabilities are impaired in autism.

In their case study, Wolk and Edwards (1993) described the phonological system of an autistic individual. The phonemic inventory of the child only contains the front nasals /m/ and /n/ (most occurrences in onset positions), but no velar nasal. (The absence of the velar nasal in this particular case could be due to two factors, namely that (1) this phoneme does not occur in onset position in English and (2) the child's tendency for coda deletion.) Moreover, voicing is also noted to be problematic, with the voiced plosives and the voiced alveolar fricative occurring more consistently than their voiceless counterparts.

Wolk and Giesen (2000), by investigating the phonologies of four ASD siblings, found that the acquisition of nasals and liquids are particularly compromised. All of the children in the study exhibit at least one kind of nasal disturbance: Child A's inventory lacks the velar nasal, Child B's *only* contains the velar nasal and glides as consonants, Child C has no labial nasal and Child D does not use nasals at all. As for liquids, Child A has trouble producing liquids in clusters and the other children either entirely lack them or their occurrence is severely limited.

Attaining the voicing contrast may also prove to be hard in autism, as the inventories of all children except those of Child A, demonstrate. For Child B, voiceless obstruents are overall absent, which makes every phoneme of his inherently voiced. For Child C, *voiced* counterparts of voiceless obstruents are only partially present and, for Child D, *voiceless* plosives and *voiced* fricatives are absent (segment inventories of the four children are included in the Appendix).

A recent study, Cleland et al (2010), has assessed the phonetic and phonological abilities of ASD children[7]. Developmental as well as non-developmental process types have been comprehensively evaluated by analyzing the speech of sixty-nine children on the autistic spectrum (a fairly large number across autism studies). Cleland et al (2010) linked a classic non-developmental array of phenomena, nasal disturbance to ASD speech: phoneme specific nasal emission, nasalization and denasalization are among the features of ASD speech. They are the first to point out that phoneme specific nasal emission[8] might be one of the non-developmental components of autistic speech. It would be useful to know their definitional criteria as well as examples for 'feature synthesis', which is also noted to be peculiar in ASD (see Illustration 32 on page 105 for the complete list of developmental and non-developmental

7 The examined disorders, high-functioning autism and Asperger syndrome, are both on the autistic spectrum.

8 Phoneme specific nasal (air) emission is a learned phonological process. The defining characteristic is a simultaneous production of an oral stop and a posterior nasal fricative as a substitution for any of the fricative, sibilant, and/or affricate sounds. Importantly, it only targets a well-defined set of phonemes, with individual differences (Peterson-Falzone and Graham (1990)).

phonological processes, as found in Cleland et al 2010).

3 Method

3.1 Subjects

The thesis analyzes speech samples of six male children diagnosed with ASD. Throughout the paper, pseudonyms and first letters thereof are used in reference to the speakers. Table 3 lists the participants, sorted by age at the time of recording.

Table 3: List of speakers (pseudonyms given, sorted by age)

Pseudonym	Age (y;m)
Misi	4;1
Bandi	4;1
Pisti	4;4
Zoli	4;7
Ákos	5;11
Feri	6;9

The only *a priori* criterion that has been used in the selection of subjects was age (no bias towards the inclusion of more communicative children, following Kjelgaard and Tager-Flusberg 2001). I wanted to include children who were as young as possible. Since autism can only be officially diagnosed after age 3 and in Hungary the autism-related screening and services are extremely limited, these children represent the youngest age group possible.

To the best of my knowledge, all available linguistic inquiries to ASD have been investigated conducted on English native speakers thus far. In this research, participants are monolingual speakers of and solely exposed to the standard variety of Hungarian. They receive daycare either at integrated kindergartens or at kindergartens for typically developing children with the specific aim of developing their language, communication as well as social skills, participants attend weekly therapeutic sessions at the *Egy Másik Út* Foundation based in Budapest (the *Egy Másik Út* Foundation is a non-profit organization run by special education teachers for children with social and language difficulties).

In the framework of TEACCH[9] (Treatment and Education for Autistic and Communication-Handicapped Children), classes span various activities, such as picture naming, story-telling, basic role playing games and logic games. Each session, individual and group alike, is highly structured and based on the actual preferences of the child (or children). Conversation is facilitated to be as spontaneous and natural as possible.

Due to Kjelgaard and Tager-Flusberg's (2001) findings and personal experience, I opted for collecting spontaneous rather than test-elicited speech. In Kjelgaard and Tager-Flusberg's (2001) experiments, approximately 10% of the participants with ASD were unable to comprehend standard tasks required by phonology and vocabulary measurements.

Note that, without exception, all the subjects who have participated in the experiment are male. The reason for this gender asymmetry is to a large degree due to autism itself: Wing (1981) found the male/female ratio in ASD to be 2.6:1 (for children living around London) and a number of researchers estimated it to be even higher, approximately 4:1 (Kanner 1943; Kanner and Eisenberg 1956; Rutter and Lockyer 1967; all cited by Wing 1981). Consequently, autism is reputed to be a male disorder, which creates a serious cognitive hindrance in screening and identifying non-prototypical, i.e. female subjects. Given these statistics, it is perhaps not surprising that at the time of this data collection, no girls attended sessions administered by the *Egy Másik Út* Foundation.

3.1.1 Preliminary findings about the general linguistic abilities of the participants

In this section, general linguistic features in the speech of two subjects are briefly discussed. The speech of the other four subjects is still under analysis.

3.1.1.1 Zoli

During the session, Zoli produced 74 utterances. Out of these, 12 was hard to interpret. Zoli vocalizes and mutters to himself a lot. He rarely uses speech for the sake of communication. His speech

9 The TEACCH approach has a long-standing tradition in the treatment of autism spectrum disorders. For more information on TEACCH-based interventions in autism see Mesibov, Shea and Schopler (2004).

is often truncated. 25% of all of his utterances are the result of immediate echolalia (e.g. session leader: *Köszönöm, [Zoli]*. 'Thank you, [child's name].', Zoli: *Köszönöm, [Zoli].* 'Thank you, [child's name].'). In the echolalic utterances, there are some cases where only the intonation of the sentence was imitated. These utterances are not added to the database. Zoli's speech comprehension is significantly better than his speech production. The following calculations are based on the interpretable, non-echolalic sentences (53 altogether).

The mean length of utterance (MLU) is a standard measurement used in child language studies. The term MLU refers to the number of morphemes that are used on average per utterance. Note that a proper measurement of the mean length of utterance should sample at least 100 completely intelligible utterances (Miller and Chapman 1981); therefore the findings at this stage should be regarded preliminary.

Zoli's vocabulary contains many holophrases (single word used as a whole phrase, e.g. *repülő?* 'airplane?', meaning 'can we play with the airplane?') and fossilized expressions (i.e. elements that always appear together) e.g. *add ide* 'give it to me' IMP, which he pronounces as if they were one word. I treated holophrases and fossilizations each as one morpheme. In Zoli's case, mono-morphemic sentences were the most frequent type of utterance (20); as the number of morphemes increased, the frequency of the sentence type dropped (16 two-morpheme sentences, 10 three-morpheme sentences, 5 four-morpheme sentences and 2 five-morpheme sentences). The mean length of utterance is 2.11 morphemes. His age equivalent according to the mean length of utterance is between 24 and 30 months (Miller and Chapman 1981), which is approximately 31-25 months behind his chronological age.

The majority of syntactic and pragmatic errors in Zoli's speech and in every participants speech is caused by echolalia. For instance, preservation of pronouns and/or of the intonation is a highly frequent phenomenon (e.g. session leader: *dobd ki, [Zoli]!* 'trash it, [child's name]' IMP, Zoli: *dobd ki!*, 'trash it' IMP).

For the complete list of phonological processes including all speakers, see the transcription of speech samples in the Appendix. Note that nasal and voice disturbances are not included here, but are discussed in Chapters 4 and 5, respectively. Here is a list of phonological processes in Zoli's speech (complete list of samples in Section 8.1):

- processes involving nasals (cf. Section 4)
- voicing processes (cf. Section 5)

- backing (plus devoicing and segment coalescence): *o*/tːv/ → /kː/*an* 'there it is'
- blending (i.e. prosody structure simplification): *má(sikat ad)d ide* → *mádide*
- centralizing: *k*/ɒ/ → /o/*mion* 'lorry'
- segment coalescence: *o*/tːv/ → /pː/*an* 'there it is'
- coda deletion: *a(z) a(z)* → *a a* 'that is the one'
- liquid simplification: /r/ → /l/*epülő* 'airplane'
- fricative simplification / fricative fronting: /ʃ/ → /s/*ajnálom* 'I'm sorry'
- onset fortitioning: /v/ → /b/*igyázz*, 'beware' IMP
- fronting: *o*/k/ → /t/*é* 'O.K.'
- heightening: *gy*/oː/ → /uː/*gyítással* 'with healing'
- insertion (achieving syllable reduplication): *autót* → *autót*/oː/ 'car' ACC
- long distance assimilation (plus segment coalescence): *nem tudom* → *ne*/p̃/*u*/p/*om* 'I don't know'
- lengthening: *e*/ɲ/ → /ɲː/*ém* 'mine'
- manner and place assimilation: *me*/tr/ → /tː/*ó* 'underground'
- cluster simplification: *é*/br/ → /b/*esztő*, 'alarm' n.
- shortening (plus devoicing): *vigyá*/zː/ → /z̥/ 'beware'
- truncation: *(vil)lamos* → *lamos* 'tram'
- lateral vocalization: *v*/ol/ → /oː/*lt*, 'was'

3.1.1.2 Misi

Misi (4;1) is one of the youngest participants in the study. During the session that is included in the database, Misi produced 217 utterances altogether. His speech was unintelligible 10 times. Slightly more than 25% of the intelligible sentences was a product of immediate echolalia (e.g. session leader: *Képzeld, nekem van otthon egy ZONGORÁM.* 'Imagine, I have a piano at home', Misi: *Zongoráá* 'piano' – capitalization indicates focus). The following calculations are made after filtering out unintelligible sentences and immediate echolalia (152 utterances altogether).

In Misi's speech, the dominating type of sentence was bi-morphemic (51 utterances). However, mono-morphemic sentences are the next most frequent with 36 utterances. Sentences with three, four, five, six and seven morphemes each followed this (30, 18, 10, 6 and 1 utterance(s) in each type respectively), which results in an MLU of 2.59. This speech pattern is clearly more complex than Zoli's, with more complex sentence types (bi-morphemic sentences are more frequent than mono-morphemic ones), the range of sentence types being broader (the emergence of sentences containing 6 and 7 morphemes) and the MLU being rated higher (2.59). Nevertheless, Misi's age equivalent based on the MLU is still well below his chronological age. The age equivalent of his MLU score is between 30 and 33 months (Miller and Chapman 1981), which corresponds to a 16-19 month delay in his language development.

Out of the questions he received during the session (125), he left unanswered approximately a fourth of them (specifically, 23% of the questions). When Misi did react to a question, he did so with an appropriate answer in 45% of the cases. In the remaining times, he imitated the question wholly or partially (32%) (e.g. session leader: *EZZEL szeretnél játszani?* 'Would you like to play WITH THIS?', Misi: *EZZEL?* 'WITH THIS?' - capitalization indicates focus). On eight other occasions he asked a question then answered it himself without waiting for an answer from someone else (e. g. Misi: *Mi ez? Egy óra.* 'What is that? A clock.').

In Misi's speech, the following phonological processes were found (complete list of samples are included in the Appendix, in Section 8.1):

- processes involving nasals (cf. Section 4)
- voicing processes (cf. Section 5)
- backing (plus devoicing and fortitioning): *e*/z/ → /c/ 'this'
- onset fortitioning: /s/ → /t/*omorú* 'sad'
- liquid simplification: *ké*/r/ → /j/*hetek* 'I can ask'
- fricative simplification: *vitorlá*/ʃ/ → /s/*hajó* 'sailing boat'
- fronting: *bekap*/t͡ʃ/ → /t͡s/*olhatom* 'I can turn it on'
- vowel heightening: *sz*/eː/ → /iː/*tesett* 'it has fallen apart'
- manner and place assimilation: *megá*/z/ → /t/*tatok* 'you got wet'
- shortening (plus fronting): *mi*/t͡ʃː/ → /t͡s/*inál* 'what is it doing'

– truncation: *betegség(et) kapt(am)* 'I got a disease'

– lateral vocalization: ba/j/ → /ɒ/ kicsit 'problem to a small extent'

3.2 Data collection and methodology

3.2.1 ASD speech samples

The speech of the participants was recorded by me on six TEACCH sessions (≈60-90 minutes each, recorded between 29/06/2009 and 01/07/2010) with a Samsung YP-U3 voice recorder. Based on the IPA transcription of these recordings, a database including all instances of the relevant phonological processes has been created. Immediate echolalia has been filtered out of the whole investigation.

Going beyond the traditional descriptive modes of analysis that is still widespread in (Spanish-English) child language literature (Javas and Goldstein 1998; Goldstein 2001; Goldstein and Citrón 2001; Goldstein and Iglesias 2001; Gorman and Kester 2002 and Goldstein et al 2005), the research focuses on systematic *segment interactions* and sound changes in particular environments. Segment inventories that merely consist of data about the 'presence' or 'absence' of segments in themselves are not informative unless (a) phonological processes are placed in a broader context, i. e. other participating segment(s) and/or the conditioning environment are known and, (b) phonemic classes are identified.

In fact, thinking in the dimension of presence or absence of a given segment may be insufficient and even misleading considering processes involving segment coalescence. For example, if nasal segments tend to get realized together with certain segments, it is not clear whether the nasal is part of the phonemic inventory of the child or not. Therefore, it is essential (a') to specify the exact phonotactic conditions in which a phonological process occurs or fails to occur and (b') to atomize interaction of phonemes into interaction of features.

For this reason, the transcriptions of the speech samples contain information not just about the underlying and surface representation of segments, but also about the phonological process the phonotactic position the process takes place.

The database comprises 452 entries. In case of more than one phonological process is relevant for a particular sample, it is included in more than one entry. The speech samples are listed in Section 8.1. In the thesis, I will call the database containing the transcriptions of speech samples the ASD database.

Each entry of the database encapsulates information about the following:

(1)	UR	– underlying representation
(2)	SR	– (adult) surface representation
(3)	ASR	– autistic surface representation
(4)	PhE	– phonotactic environment
(5)	Sample	– sample taken from recorded speech
(6)	Gloss	– raw translation of the sample
(7)	PhP	– phonological process
(8)	Speaker	– pseudonym of the speaker

In Section 8.1, the entries are sorted by phonological process, phonotactic environment and speaker. The underlying representations (UR) of children are regarded identical to the adult ones. In the entries, surface representation (SR) is only to be filled out when different from underlying representation (UR), in the other cases left blank. In addition to that, the blending and truncation processes are not transcribed, only the sample and the translation is given. Therefore, I left both the underlying and the surface representation of these samples empty. Surface representation contains forms that result from both phonemic and phonetic changes. The reason behind this is that considering especially the voicing processes, the boundary between phonology and phonetics is not clear. I will not try to resolve this issue in the thesis.

Autistic surface representation (ASR) is shown every time. In the absence of a phonological process, the field PhP contains the null-set symbol '∅'. Otherwise, it contains the abbreviation of the process (to be found in Table 1 on page 6). Parts of words that are truncated by the participants are included in parentheses.

Before going further, it is indispensable to clarify in what sense the term 'cluster' and 'sequence' will be used in the thesis: it means no more than a group of adjacent consonants, without the requirement of monosyllabicity. Thus, any two consonants without an intervening vowel are treated as a cluster. 'Sequence' will be used both for consonant-consonant (CC) and vowel-consonant (VC) groups.

The listing of examples are sub-categorized into phonotactic environment and sorted by speaker. In text, minimally one sample is provided from every speaker if applicable. All further examples are listed in the Appendix, sorted by (1) phonological process (2) phonotactic environment (3) (pseudonym of the) speaker.

For later reference, it might as well be crucial to rigorously differentiate between the positions a phonological process takes place (or fail to take place for that matter) because that could give a detailed picture about the application range of the process. Therefore, phonotactic environments within and beyond the syllable are considered.

For singleton consonants, the phonotactic alternatives are being in a word-initial onset (WIO), word-medial onset (WMO), word-medial coda (WMC), word-final coda (WFC); or, for a monopthong, in the nucleus (NUC). If clusters (consonant-consonant sequences) are discussed in the corpus, in case there is no boundary between the segment sequence, the position within the syllable is specified: onset-cluster (OCL) or coda-cluster (CCL). Other possibilities involve boundaries separating the sequence; such as, syllable boundary – SCL, morpheme boundary – MCL, and, for the processes of nasal coalescence and voicing assimilation, word boundary – WCL also might play a role.

3.2.2 Standard speech samples

Speech samples of Standard Hungarian originate from Siptár and Törkenczy (2000) and Morén (2007 a-c). In order to provide spectral images for aforementioned sources, a database of acoustic representation of CC-clusters in Standard Hungarian has been put to use (Olaszy 2007). It is an online database, created for the purpose of supplying researchers with representations of words containing CC-combinations uttered by two different speakers (male and female). Transcriptions and sound boundaries are already added to each waveform and spectrogram. Subsequent illustrations of spectrograms originate from this database (hereafter Olaszy database). Note that it contains some nonsense words for the purpose of demonstrating all well-formed consonant combinations. Note that the spectrograms are arranged in pairs.

As for the spectrograms, I chose each to be produced by a male speaker. The orthography of the analyzed word appear in the upper left part of the spectrogram. Also note that the highlighted segments in the word may not be the segments in question. Since the transcriptions of segments are not given in IPA, I will provide the IPA notation.

In providing a comparison to the ASD speech samples, adult production (provided by the Olaszy database) has been investigated. The structure of the items given demonstrating the adult production essentially follows the already introduced pattern in the ASD entries, with the obvious exclusion of (2) and (8):

(1) UR – underlying representation
(2) SR – surface representation
(3) PhE – phonotactic environment
(4) Sample – sample the cluster occurs in standard production
(5) Gloss – raw translation of the sample
(6) PhP – phonological process

3.3 Theoretical background: Feature geometries

According to Chin and Dinnsen (1991), feature geometry compares favorably with more conventional descriptions of disordered phonological systems. In their article about describing phonological processes in the speech of phonologically disordered children, Chin and Dinnsen (1991) argue that feature geometries are more suitable to the purposes of description of disordered phonologies than descriptions based on merely the IPA's three dimensions of place, voice and manner and distinctive feature theories.

Conventional approaches to disordered languages applied the International Phonetic Alphabet (IPA in short) (International Phonetic Association, 1999). In the IPA chart in Illustration 2, each segment could be characterized along the dimensions of manner (horizontal direction), place (vertical direction). Grids may be further divided into voiceless and voiced segments (where symbols appear in pairs, the one to the right represents the a voiced consonant, except for the murmured /ɦ/). For example, the phoneme /b/ is produced by obstructing airflow in the vocal tract (*plosive* manner of articulation), articulated with both lips (*bilabial* place of articulation) and with vibrating vocal folds (*voicedness*). Thus, one can refer to the phoneme /b/ as a voiced bilabial plosive.

	LABIAL		CORONAL				DORSAL			RADICAL		LARYNGEAL
	Bilabial	Labio-dental	Dental	Alveolar	Palato-alveolar	Retroflex	Palatal	Velar	Uvular	Pharyngeal	Epi-glottal	Glottal
Nasal	m	ɱ		n		ɳ	ɲ	ŋ	ɴ			
Plosive	p b	ȹ ȸ		t d		ʈ ɖ	c ɟ	k ɡ	q ɢ		ʡ	ʔ
Fricative	ɸ β	f v	θ ð	s z	ʃ ʒ	ʂ ʐ	ç ʝ	x ɣ	χ ʁ	ħ ʕ	ʜ ʢ	h ɦ
Approximant		ʋ		ɹ		ɻ	j	ɰ				
Trill	ʙ			r					ʀ		я	
Tap, Flap		ⱱ		ɾ		ɽ						
Lateral fricative				ɬ ɮ		ꞎ	ʎ̝	ʟ̝				
Lateral approximant				l		ɭ	ʎ	ʟ				
Lateral flap				ɺ		ɭ̆						

Illustration 2: Pulmonic consonant chart in the International Phonetic Alphabet (International Phonetic Association, 1999) Shaded areas denote articulations judged to be impossible. Light grey letters are unofficial extensions to the IPA.

The IPA offers a very convenient method to describe segment inventories. Along the three dimensions of voice, manner and place, different classes of sounds (the voiced sounds, the bilabials, the plosives etc.) can be captured and a large number of phonological processes involving these classes can be summarized (e.g. in a given language, all voiceless segments turn voiced in a certain phonotactic position, a summary of voicing assimilation).

However, there are some problems that cannot be eliminated by a simple IPA description. First, some phonological processes may require more machinery that can be covered by an IPA description. When referring to more than one row or column, it has to be done by listing the respective classes ("dentals and alveolars", "labials and velars"). Second, the descriptive nature of IPA does not offer an explanation why the articulation of certain sounds deemed impossible or at least are unattested. In sum, neither the possible combinations of natural classes, nor the gaps in the combinations are satisfactorily accounted of.

Another method that has been used in characterizing disordered phonologies comes from distinctive feature theories. Distinctive feature theories, such as SPE (from the name 'Sound Pattern of English', outlined by Chomsky and Halle 1968) characterize a phoneme with matrices of binary phonetic features. In their own words, each phoneme '*[...] in the lexicon [is] represented as a two-dimensional matrix in which the columns stand for the successive units and the rows are labelled by the names of the individual phonetic features*' (Chomsky and Halle 1968: 296).

The feature inventory of a given language exhaustingly lists all features that can constitute a phoneme. Binary features can take two values, either + or –. For demonstrational purposes, the lexical entry of /b/ in SPE would be described with a bundle of manner, place (vocal tract) and major class features. The first column contains the features and the next comprises the matrix of binary feature specifications of the voiced bilabial plosive.

Illustration 3: SPE description of the voiced bilabial plosive (incomplete)

		b
VOICE	(produced with vocal fold vibration)	+
CONTINUANT	(produced with incomplete closure in the vocal tract)	–
ANTERIOR	(produced in the anterior cavity of the mouth)	+
CORONAL	(produced with the tongue)	–

CONSONANTAL (belonging to the major class of consonants)	+

The apparent problem with the SPE feature system is again the lack of explanatory power. On the one hand, there is no clear motivation behind why the attested combinations of features are permitted and why the unattested ones are unattested, on the other. One can also ask what legitimizes the status of features (e.g. why is the feature +CONSONANTAL necessary?), what keeps features together and makes them to act in concert (instead of +ANTERIOR and –CORONAL, why not simply use +LABIAL?).

Additionally, it is not clear what advantage can be gained by using binary-valued features in feature theories (does properties of phonemes should be expressed as oppositions of two values? what do –CORONAL, –CONSONANTAL etc. exactly mean and what could motivate their usage?).

In SPE, matrices of phonemes are totally independent from each other, no overlapping feature specifications are allowed. Therefore, SPE in itself is not a sufficient tool to capture segment interactions, such as place assimilations or segment coalescences.

Feature geometries, starting with Sagey's (1986) proposal and autosegmental phonology (Goldsmith 1976), try to eliminate these deficiencies. By introducing hierarchy in the feature inventory, feature geometries organize features into meaningful units. Groups of features that behave together, are established. Sagey (1986) introduces the notion of 'skeletal tier', which is the topmost tier in the feature geometry.

In Sagey's (1986) model, the skeletal tier contains two kinds of nodes. The consonantal or C-node represents the non-syllabic segments and the vocalic or V-node represents the syllabic ones. Each C and V-node dominates a so-called root node, which constitutes the structural representation of a phoneme. Features are linked under the dominating root node by association lines. Illustration 4 provides a schema of all possible featural extensions of the consonantal, non-syllabic segment. Here is shown that features such as [round] presuppose and are dependent on a whole chain of features: [labial] – [place] – [supralaryngeal].

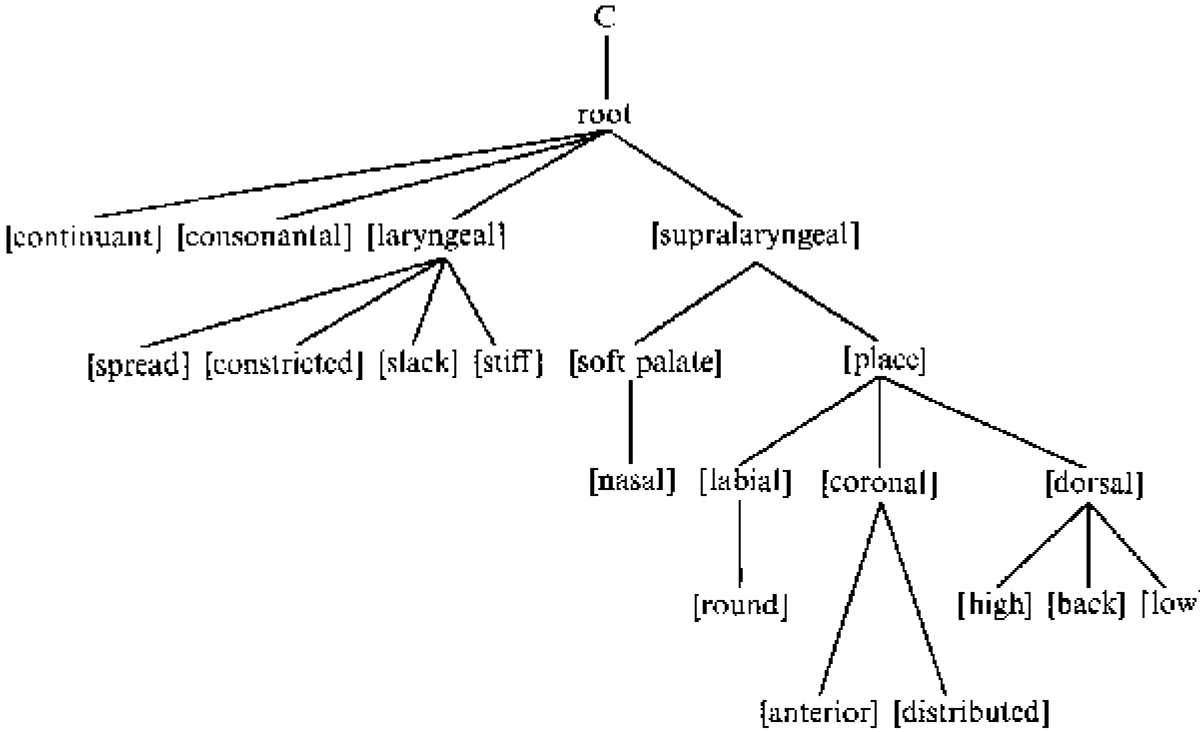

Illustration 4: Feature geometry of the C-node by Sagey (1986)

With feature geometries, representations of various segment assimilations and harmonies became possible. Being packed next to each other in a string, these individual bundles of features can influence each other. A node dominated by one root node can be associated with another root node as well. Assimilation is thus represented as a spread of nodes of features. In place assimilation, for instance, it is the place node that gets re-associated to another segment's root node. By imposing these rules on structure, feature associations and re-associations, the feature geometric system is able to draw the line between possible and impossible structures, *contra* descriptive theories.

Although feature geometries have been mainly employed for defining the characteristics of standard languages, Chin and Dinnsen (1991) claimed that their application may be extended to the description of phonological disorders. They demonstrated the feasibility of internal hierarchical organization of feature geometries on three phonological phenomena, one of which is segment coalescence. For example, /s/ plus consonant clusters are fused together in the examined speech of phonologically disordered children[10].

10 The study of Chin and Dinnsen (1991) comprised forty children ranged in age from 3;4 to 6;8. All had at least six sounds in error across three manner categories in the Goldman-Fristoe Test of Articulation (Pearson Assessment and Information),

Deriving a single sound from two poses a problem for both place-voice-manner and distinctive feature theories. The existing difficulty with the *ad hoc* nature of matrices attached to individual segments perseveres if interactions between segments are considered. Feature geometries, however, by virtue of re-association of features, are able to represent segment changes coming from interactions, among them coalescence (re-association is also known as spreading of the feature).

To summarize, this section first presented reasons in support of using feature geometric models in the description of disordered phonologies. The rationale behind the feature geometric approach is that (1) it goes beyond description by only permitting attested combinations of features and excluding those of unattested. Also, feature geometries (2) highlight a more sophisticated internal structure of segments by hierarchically relating the features, and, (3) allow overlapping structure between adjacent segments, accommodating explanations for segment interactions.

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but fell within normal limits on other tests including hearing acuity and receptive vocabulary (Dunn and Dunn 1981, cited by Chin and Dinnsen 1991). Seven of them exhibited coalescence.

3.4 The Parallel Structures Model

Taking further this line of argumentation, the phonological analysis this thesis introduces makes use of the Parallel Structures Model of feature geometry. The Parallel Structures Model (henceforth PSM) is a novel framework of feature geometry, developed by Morén (2003a-b, 2006a-b, 2007a-c). This thesis employs this model as opposed to other feature geometries for the following reasons:

(1) the PSM offers simple unified representations for consonants and vowels, therefore it reduces structures and feature set to the absolute minimum.

(2) Assuming parallel structures at multiple levels of representation helps to capture a number of consonant-vowel interactions and segment alternations.

With the unified representation of segments, Morén constructs a minimal feature theory from the bottom up. As the name of the model shows, in the PSM consonants and vowels exhibit essentially identical structures. The PSM applies a single skeleton for characterizing all the segments. This skeleton consists of 'consonant-class' and 'vowel-class' nodes. The labels do not necessarily correspond to actual consonant and vowel feature specifications, but as a rule of thumb, consonantal segments are specified on the consonant-class node and vowels on the vowel class node. Class nodes are optionally furnished with generally two kinds of features, place (= articulator-based) and manner (= constriction-based) features (see Illustration 5 for visual aid).

Morén follows Clements (1991) in the placement of vocalic nodes. Vocalic nodes become dependent on the consonantal nodes, with which place harmony asymmetries are accounted for (universal lack of consonant harmony versus abundance of vowel harmony across languages, see Clements 1991). Further, the PSM extends the notion of node dependence from place nodes to every node structure.

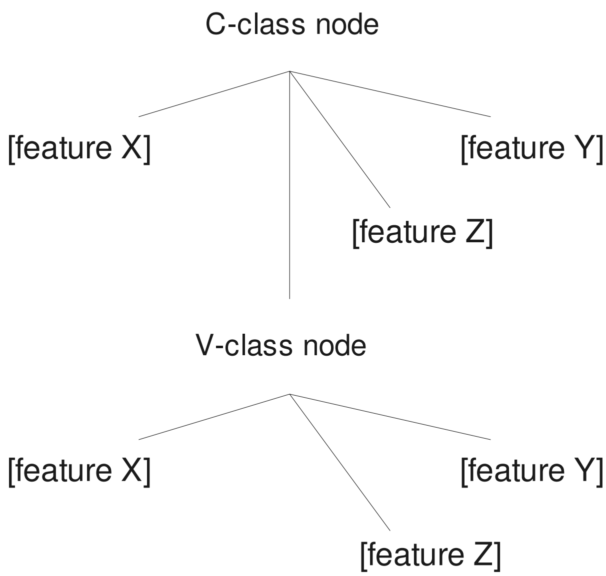

Illustration 5: Segment skeleton in the PSM (Morén 2003)

In addition, the PSM is also radically minimal due to the reduced feature inventories at every level of segment representation. Feature unification proved to be extremely helpful in explaining segment interactions, alternations, coalescences and harmony asymmetries, such as high vowel-sonorant alternations in Yi (Dell 1993, cited by Morén 2003), lateral vocalization and non-labial iotization in Serbian (Morén 2006a), various place and manner assimilations in Standard Hungarian (Morén 2007) and Cairene dorsal harmony (Youssef 2007).

In the PSM, features are privative (i.e. unary-valued). By choosing the features to be privative one can avoid questions raised in the previous section about the status of the negative-valued features. Moreover, instead of introducing major class features, the basic distinctions between consonant and vowel and sonorant and obstruent are simply encoded in the representations. Consonant specification generally takes place on the C (i.e. independent) node, while vowel specification on the V (i.e. dependent) node.

As shown, Illustration 5 contains the schematic skeleton of segments in the PSM. Illustration 6 and Illustration 7 are manifestations of the abstract structure to the dimensions of place and manner, respectively.

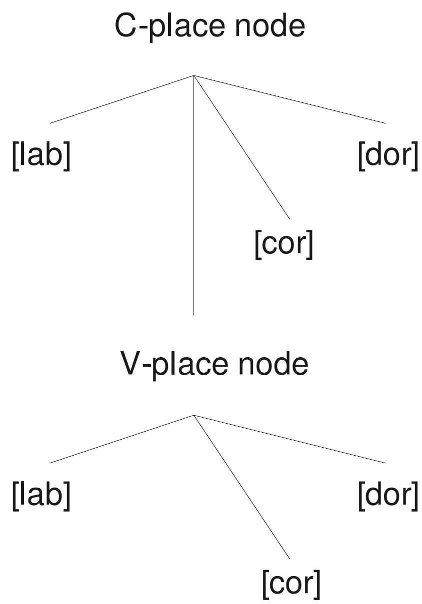

Illustration 6: Place of articulation (Morén 2006a)

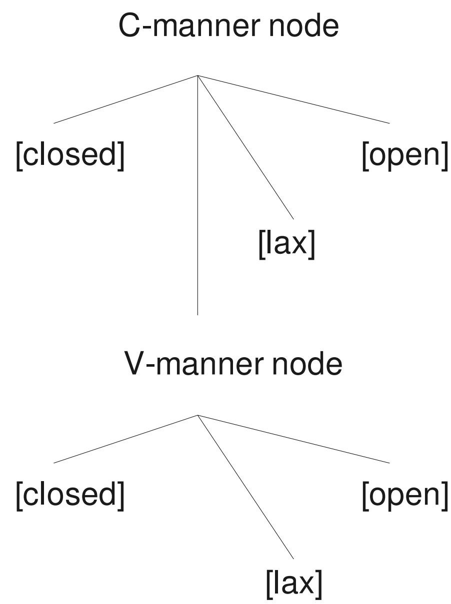

Illustration 7: Manner of articulation (Morén 2006a)

Standard generative phonology assumes that features of distinctive phonemes are hard-wired in the human articulation system and; therefore, they are innate (Chomsky and Halle 1968, Halle 1983). Morén (2003a) argues that, by extending the scope of discussion to phonologies rooted in alternative modalities, taking sign languages to be the prime example, it is not tenable to attribute innateness and universality to feature and structure thereof. The structure is not assumed to be derived from parts of the vocal tract (substance-free phonology, Hale and Reiss 2000).

Instead, Morén (2006a) proposes to define feature inventories language-specifically; adjusting skeletons to the needs of the language in question. In the PSM, features *emerge,* given overt, positive evidence from the input (cf. Mielke's (2006) concept of emergent feature theory).

The PSM segment inventories of Standard Hungarian are found in Section 8.2. As noted earlier, feature geometries are uniquely suited to represent various segment interactions and segment coalescences by means of re-association of features. In this thesis I give representational analysis in the spirit of the PSM for processes involving nasals:

(1) nasal place assimilation in Standard Hungarian (Section 4.2)

(2) nasal coalescence in Standard Hungarian (Section 4.3)

(3) nasal coalescence in ASD speech (Section 4.4).

I do not make an attempt to extend the phonological analysis to the processes of voicing assimilation, voicing and devoicing (to be discussed in Chapter 5) because voicing assimilation generally poses problems for feature geometries operating with privative features. The dilemma for geometries applying the [voice] feature is how to account for both the process of 'voicing' and 'devoicing' in terms of re-association of features.

One way of handling the problem might be to claim that voicing assimilation is a product of laryngeal neutralization. Since voicing assimilation in Hungarian involves both voicing and devoicing of the first member of the cluster, depending on the voicing value of the second member (discussed in Chapter 5.1). I do not take a stand in this issue and choose not to analyze voicing processes in the PSM.

In sum, this section briefly presented the feature geometry I have chosen to apply. The Parallel Structures Model is an economical system with regard to both the levels of representation and the feature inventory. It is empirically founded, because it only assumes features and structures based on the properties and phonemic contrasts of a given language. By the internal hierarchical representation of segments and permitting re-association of features, the PSM is able to capture segment interactions. After their description, the next chapter provides a phonological analysis of nasals and nasal processes in the PSM.

4 Processes involving nasals

4.1 General properties of nasals

Nasals are noted for their hard-to-characterize behaviour both from a cross-linguistic and from an intra-linguistic point of view. By articulatory definition, nasals can be regarded both sonorants (no restriction on the nasal escape of air) and obstruents (the oral cavity is most typically blocked). Despite this seeming complexity, nasals are fairly common segments: approx. 96% of the languages in the UPSID (UCLA Phonological Segment Inventory Database, Maddieson and Precoda 1989) distinguish phonemic nasals.

Nasals are also acquired early in neurotypical development. Jakobson (1941) was the first postulating that infants acquire classes of sounds, instead of individual sounds. Jakobson (1941) claims that the milestones of acquisition are universal across languages (he was not aware of languages that do not distinguish nasals phonemically). The course of acquisition is determined by the phonological universals, i.e. salient features of sounds. Within the Jakobsonian model, the second phonemic contrast a language learner makes is between oral and nasal sounds, right after distinguishing between consonants and vowels (Jakobson 1941).

The basic CV syllable	The maximal contrast in the syllable is between closure and opening. The maximal closure is a labial stop (which seals the entire vocal tract); the maximal opening is the vowel /a/.
Nasal vs. oral consonants	The maximal contrast within consonants is the obstructed oral cavity in contrast to the open nasal cavity.

Illustration 8: The first phonemic oppositions acquired by children (Jakobson 1941)

In phonological disorders, however, standard acquisition of nasals (i. e. precise coordination of the velum with other muscles involved in speech) may be challenging. Hyper- and hypo-nasalization is a frequent concomitant of phonological disorders (Grunwell 1985).

In his main work on the PSM, Morén (2003a) adopted an agnostic view concerning the place of nasal feature in the model. In an acquisition lecture, Morén (2003b) offered an explanation for the dual nature of nasals, by assuming them to be analyzed as "obstruents with a nasal feature", at least at the initial stage of acquisition. He hypothesized that reanalyzing occurs if positive evidence for nasal sonorancy can be inferred from the language (see Fikkert 2007 for the Dutch course of phonological development).

With regard to the status of the nasal in Standard Hungarian, Morén (2007) does not take up an single [nasal] feature. Instead of a using a [nasal] feature, he rather defines nasality representationally (as a combination of features), due to the marginal status of nasalization and nasal processes in general. In Standard Hungarian, nasalization primarily occurs in fast speech; therefore, it is legitimate to avoid the introduction of an independent [nasal] feature. This account chooses to accommodate the single [nasal] feature because of the extreme predominance of nasalization over preserving the nasal segment in ASD speech.

4.2 Nasal place assimilation in Standard Hungarian

Nasal place assimilation is a cross-linguistically frequent phenomenon. Nasal place assimilation occurs when a nasal consonant assimilates the place features of another preceding or following consonant in its environment. Many times, nasal place assimilation creates nasal allophones that are not otherwise present in the language and can only occur in a specific environment (see next paragraph for the Hungarian examples). According to Jusczyk et al (2003), assimilation of the nasal to the other segment and not vice versa is a universal tendency across languages.

Siptár and Törkenczy (2000) and Morén (2007) note that out of the six nasal consonants that appear on the surface, three of them are phonologically contrastive in Standard Hungarian. The labio-dental, the palato-alveolar and the velar nasals can only occur in a specific segment environment, i.e. following a homorganic consonant (samples taken either from Siptár and Törkenczy (2000) or the Olaszy cluster database). In other words, the labial nasal /m/ is resistant to assimilation, except when followed by labiodentals. In that case, it emerges as a labio-dental nasal. The coronal nasal /ɲ/ only assimilates to palato-alveolars, yielding a palato-alveolar nasal. Examples of each phonetic nasal are shown in the surface representation column of Table 4.

Table 4: Phonetic nasals in Hungarian – labio-dental, palato-alveolar, velar

UR[11]	SR[12]	PhE[13]	Sample	Gloss	PhP[14]
mf	ɱf	MCL[15]	*som+fa*	'wormwood'	POA[16]
ɲt͡ʃ	n̄t͡ʃ	MCL	*fény+cső*	'fluorescent lamp'	POA
nv	ɱv	MCL	*ken+ve*	'it is smeared'	POA
nt͡ʃ	n̄t͡ʃ	CCL[17]	*nincs*	'none'	POA
ng	ŋg	MCL	*üzen+get*	's/he keeps sending messages'	POA

The labial-, alveolar- and palatal nasals, conversely, freely emerge in any position, without the need of a triggering environment. The labial and palatal nasals are both resistant to assimilation (with the exceptions previously shown in Table 4). As the examples in Table 5 illustrate, the surface representations of labial nasal + consonant clusters and the palatal nasal + consonant clusters are identical to the underlying representation (the spectrogram for the palatal nasal + velar plosive cluster suggests in the first spectral image of Illustration 9 that there might be an incomplete assimilation taking place, but the palatal is nevertheless present).

Table 5: Phonemic nasals in Hungarian – labial and palatal

UR[11]	SR[12]	PhE[13]	Sample	Gloss	PhP[14]
mj		MCL[15]	*korom+ja*	'his/her soot'	∅
mk		MCL	*film+klub*	'film club'	∅
ɲk	ɲ͡ŋk	MCL	*fény+kép*	'photo'	∅
ɲb		MCL	*torony+ba*	'into the tower'	∅

Illustration 9 contains two spectrograms from the Olaszy database of Standard Hungarian. The first spectrogram shows a labial nasal + palatal consonant cluster, the second a palatal nasal + velar consonant cluster, both of them show that labial and palatal nasals do not undergo place of assimilation.

11 Underlying representation
12 Surface representation
13 Phonotactic environment
14 Phonological process
15 Cluster across morpheme boundary
16 Place of assimilation
17 Coda cluster

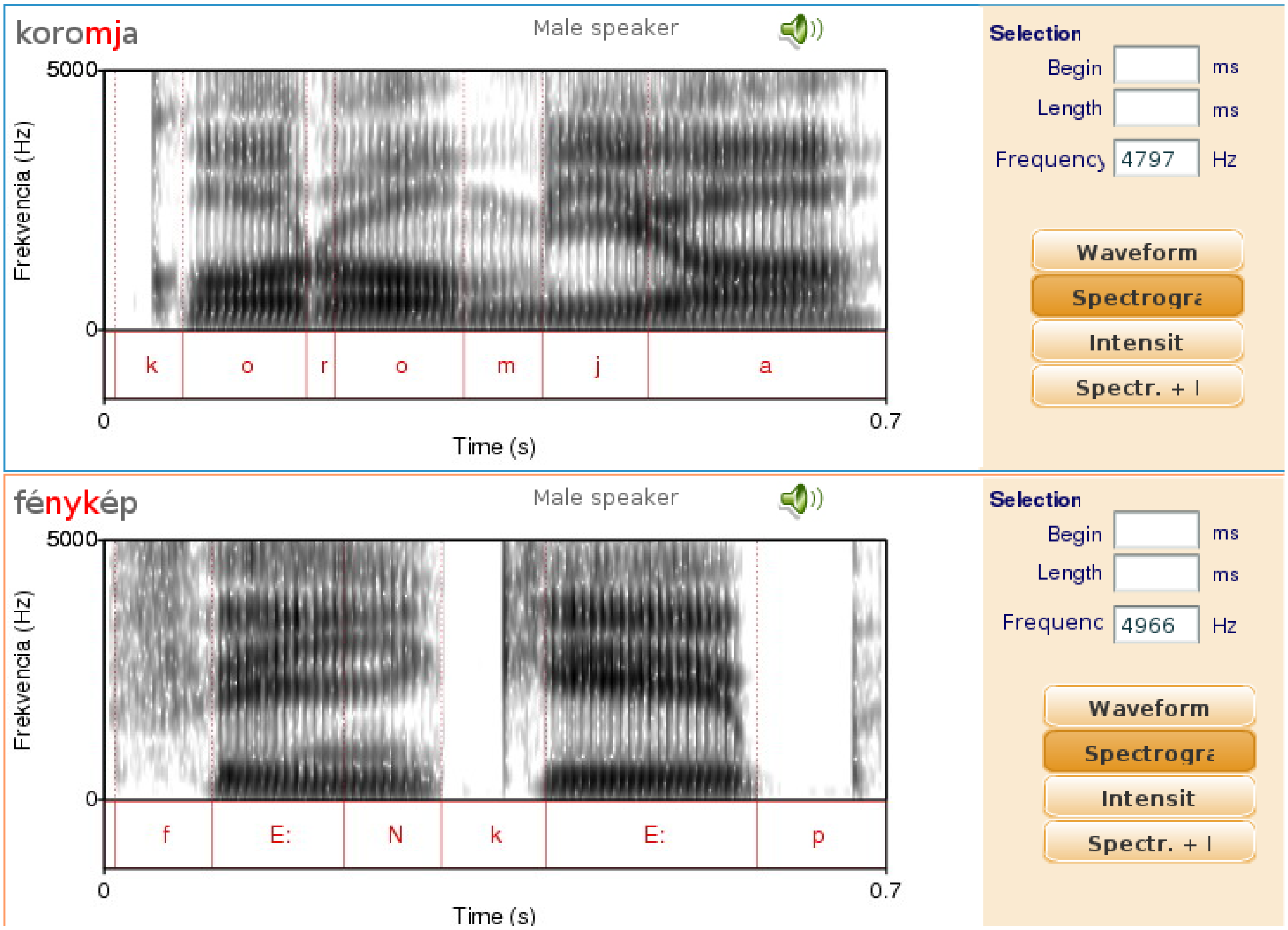

Illustration 9: Spectrograms of nasal place assimilation – no assimilation in labial and palatal nasal clusters (Olaszy 2007). Spectrogram 1: /mj/ → [mj]. *Spectrogram 2:* /ɲk/ → [ɲ͡ŋk]

The occurrence of the alveolar nasal is the most restricted among the phonemic nasals. It only surfaces unchanged when followed by a vowel, an alveolar consonant or a phrase boundary (all exemplified in Table 6).

Table 6: Phonemic nasals – alveolar

UR[11]	SR[12]	PhE[13]	Sample	Gloss	PhP[14]
n		WIO[18]	*nagy*	'large'	∅
n		WMO[19]	*vandál*	'vandal'	∅

18 Word-initial onset
19 Word-medial onset

UR[11]	SR[12]	PhE[13]	Sample	Gloss	PhP[14]
n		WFC[20]	*olyan*	'such'	∅

In all the other cases, however, the alveolar nasal is always realized as homorganic with the following consonant, regardless of syllable, morpheme or word boundaries. The assimilation of the alveolar nasal to the following consonant is the example of nasal place assimilation in Hungarian. Table 7 shows that the alveolar nasal + bilabial consonant cluster surfaces as bilabial nasal + bilabial consonant (first entry of Table 7), plus, the alveolar nasal assimilates to the bilabial nasal (second entry of Table 7), which results in a long nasal. Moreover, the alveolar nasal also assimilates to the oral palatal (third entry of Table 7) and to the nasal palatal as well (fourth entry of Table 7).

Table 7: Nasal place assimilation – place of assimilation of the alveolar to the following consonant

UR[11]	SR[12]	PhE[13]	Sample	Gloss	PhP[14]
nb	mb	SCL[21]	*különb+ség*	'difference'	POA[16]
nm	mː	WCL[22]	*van#már*	'there is already'	POA
nc	ɲc	CCL[17]	*pinty*	'finch'	POA
nj	ɲ	MCL[15]	*konszern+jeit*	'its concerns'	POA

20 Word-final coda
21 Cluster across syllable boundary
22 Cluster across word boundary

In Illustration 10, the first spectrogram shows the place assimilation of the alveolar nasal to the following labial plosive /p/ (exemplification of the first entry in Table 7). The second spectrogram contains the exemplification of the second entry in Table 7, i. e. the place assimilation of the alveolar nasal to the bilabial nasal, which creates a long nasal.

Similarly, Illustration 11 contains two spectrograms, one of which shows the alveolar nasal assimilating to the palatal oral (note that the palatal plosive is spirantized by the following fricative), the other of which is the alveolar nasal assimilating to the palatal nasal (exemplifications of the third and fourth entry in Table 7). Note that in the first spectral image also shows partial devoicing of the bilabial plosive due to voicing assimilation (discussed in Section 5.1).

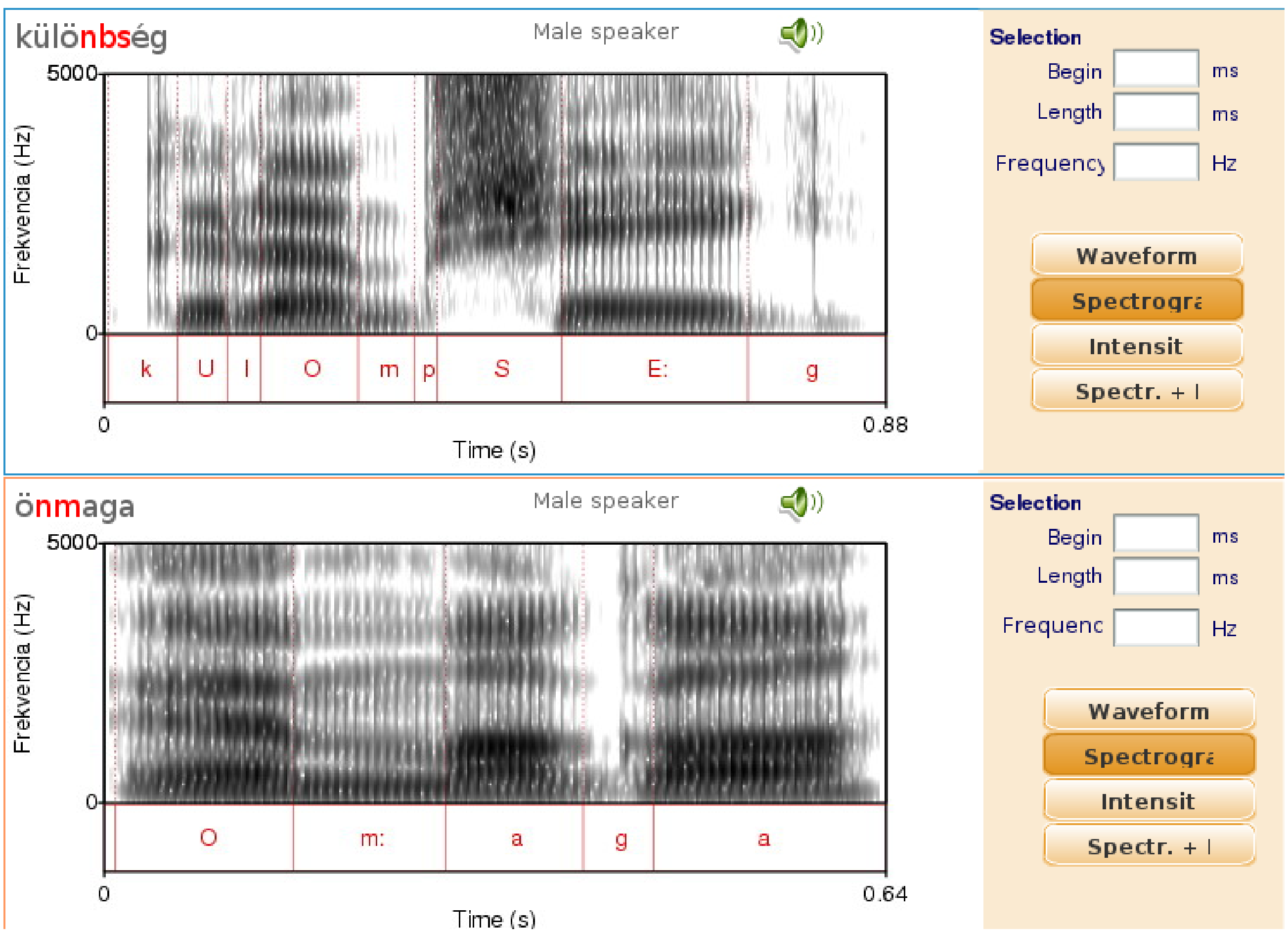

Illustration 10: Spectrograms of nasal assimilation in alveolar nasal + labial clusters (Olaszy 2007). Spectrogram 1: /nbs/ → [mps]. *Spectrogram 2:* /nm/ → [m:].

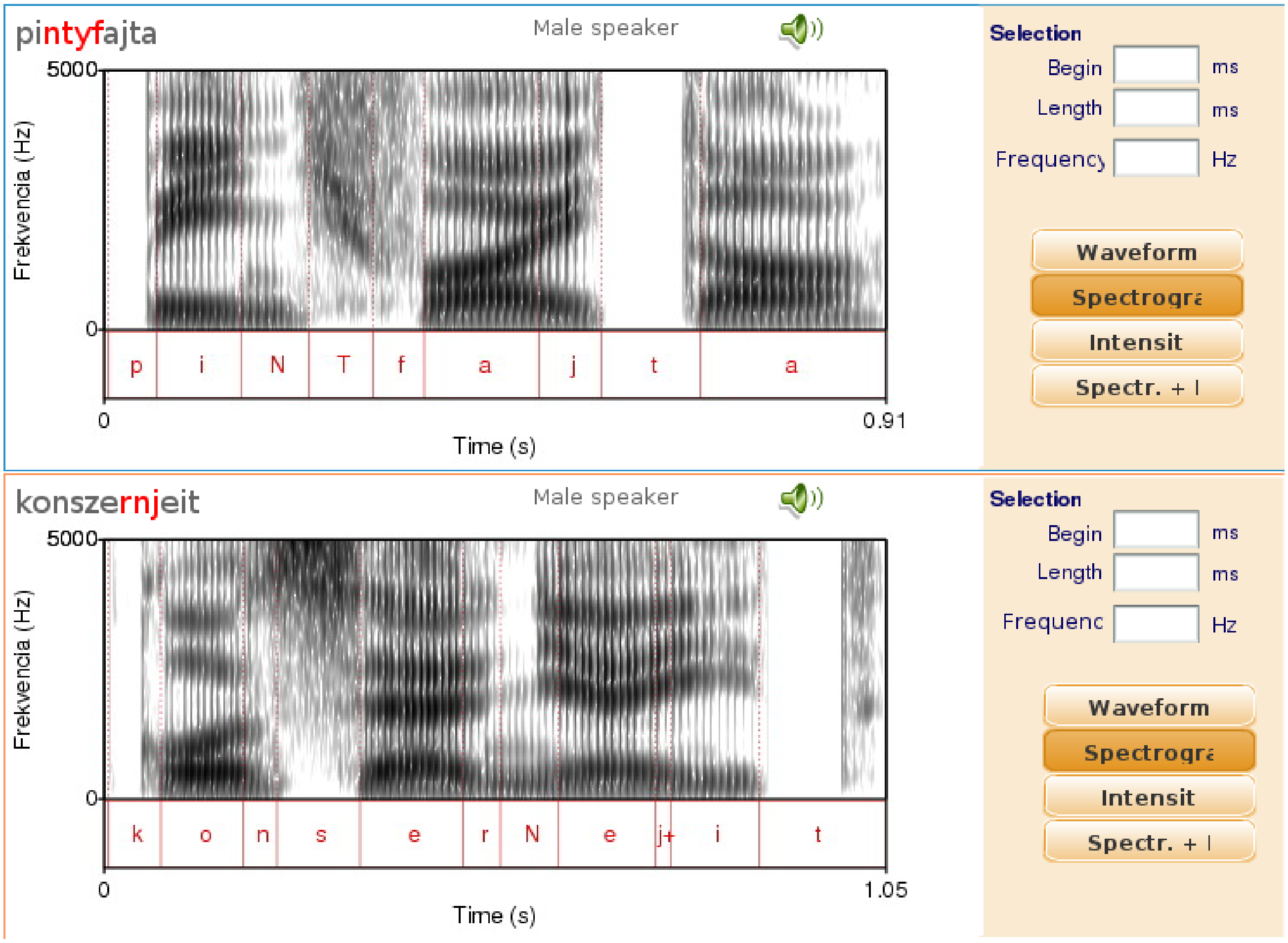

Illustration 11: Spectrograms of nasal place assimilation in alveolar nasal + palatal clusters (Olaszy 2007). Spectrogram 1: /nc/ → [ɲç]. Spectrogram 2: /nj/ → [ɲ].

Illustration 12 and Illustration 13 show the place feature re-association in nasal place assimilation in my analysis using the PSM. In both cases, the pre-consonantal nasal has no specification for place. The second segment holds specification for place and regressively spreads the feature to the nasal. In Illustration 12, the second member of the cluster is an oral labial, in Illustration 13, it is a nasal labial. Without place specification on the second member of the cluster, both segments would surface as alveolars (as Illustration 14 shows with the alveolar nasal + alveolar plosive cluster).

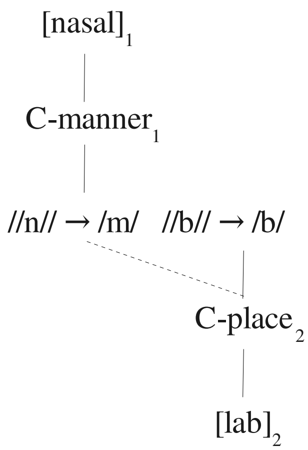

Illustration 12: PSM Representation of nasal place assimilation to oral labial

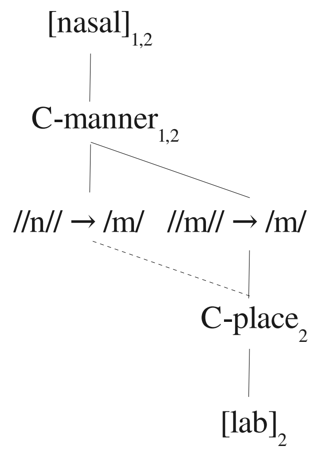

Illustration 13: PSM Representation of nasal place assimilation to nasal labial

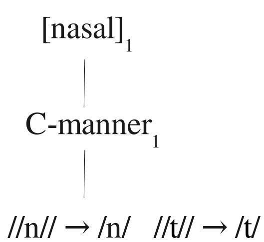

Illustration 14: PSM Representation of nasal alveolar + alveolar cluster

Illustration 15 and Illustration 16 also show how the alveolar nasal assimilates, this time to the oral palatal (Illustration 15) and to the nasal palatal (Illustration 16). Both palatals are specified for place as coronals (following Morén 2007c, cf. Section 8.2).

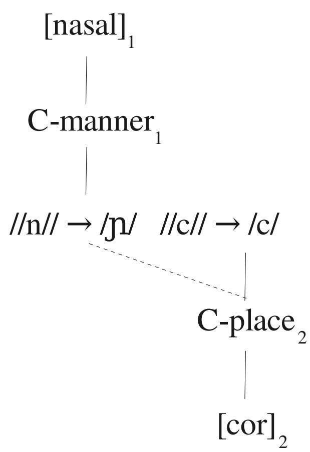

Illustration 15: PSM representation of nasal place assimilation to oral palatal

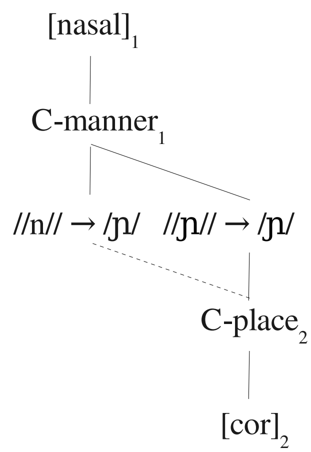

Illustration 16: PSM representation of nasal place assimilation to nasal palatal

To summarize, this section outlined the set of phonetic and phonemic nasal inventory as well as the domain of nasal place assimilation in Standard Hungarian. The phonetic inventory contains the labio-dental /ɱ/, the palato-alveolar /n̄/ and velar nasal /ŋ/ (Table 4). The phonemic nasals are the labial /m/, the palatal /ɲ/ (Table 5) and the alveolar /n/ (Table 6). Nasal place assimilation occurs in alveolar nasal + consonant clusters, across any boundary. The alveolar nasal assimilates both to labial and palatal consonants (examples in Table 7, spectrograms in Illustration 10, Illustration 11). The featural representations of nasal place assimilation using the PSM are found in Illustration 12, Illustration 13, Illustration 15 and Illustration 16.

4.3 Nasal coalescence in Standard Hungarian

Another nasal process involving alveolar nasal-continuant clusters in Hungarian is described in Siptár and Törkenczy (2000).[23] The process of nasal coalescence involves a vowel and a nasal + continuant cluster following the vowel (the cluster may be formed across phonotactic boundaries, i.e. syllables, morphemes and words). In Table 8, the long open unrounded vowel /aː/ surfaces as nasalized and the alveolar nasal is deleted from the surface representation. The conditioning environment (the environment in which the process takes place) is a continuant following the nasal, in this case the

23 The phonetic background for different levels of nasalization in terms of highness, frontness and continuity is thoroughly discussed in Schourup (1972).

alveolar fricative /s/. Up to various levels, not just the vowel, but the continuant neighboring the nasal continuant may also get nasalized. Note that the process is optional, it generally occurs in casual/fast speech.

Table 8: Vowel nasalization / nasal deletion

UR[11]	SR[12]
aːns	ã͡ːs

The process would be hard to characterize in a distinctive feature theory. It has to be divided into two sub-processes: the nasalization of the vowel and the deletion of the nasal. This analysis adopts the name 'nasal coalescence' instead of Siptár & Törkenczy's (2000) term 'nasal deletion/vowel nasalization' because 'nasal coalescence' captures the fact that features of two segments are retained and simultaneously realized, by forming a single unit on the surface. By conceptualizing the process as a merge the two segments, the length of the resulting nasalized vowel is also accounted for (note the lengthening of the vowels in the second and third entries of Table 9). Table 9 shows three examples with different phonotactic environments (in coda cluster, across morpheme and word boundary). Optionality of nasal coalescence is indicated in the surface representation.

Table 9: Nasal coalescence in Standard Hungarian (optional)

UR[11]	SR[12]	PhE[13]	Sample	Gloss	PhP[14]
aːns	aːns / ã͡ːs	CCL[17]	*elegáns*	'elegant'	COA[24]
onh	onh / õ͡ːh	MCL[15]	*ton+hal*	'tuna fish'	COA
onl	onl / õ͡ːl	WCL[22]	*olyan#lassú*	'so slow'	COA

In the Olaszy database for Standard Hungarian speech, signs of nasalization of the preceding

24 Coalescence

vowel[25] are detected in the spectral images.[26] Signs include the increase of formant bandwidths of the vowel (point 1 in footnote 25) introduction of a low-frequency nasal formant with a center frequency of about 250-500 Hz for adult males (point 3 in footnote 25). However, the nasal segment is not deleted in the expected context, possibly due to the fact that these speech samples are carefully produced, at a slow speech rate.

Illustration 17 contains two spectrograms. One of them contains the mid-front rounded vowel /ø/, the alveolar nasal and the alveolar fricative. The vowel is slightly nasalized, which can be see on the broadening of bandwidths, but the nasal is also present. Similarly, the second spectrogram shows the back rounded vowel followed by the alveolar nasal-fricative cluster. The result is again nasalization, which can be seen by the abovementioned low-frequency nasal formant.

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25 A brief recap on the spectral cues of a nasalized vowel (Kent and Read (1992, cited by Riaz 2001):

(1) Increase in formant bandwidth, so that formant energy appears broader.
(2) Decrease in the overall energy of the vowel (compared to non-nasal vowels)
(3) Introduction of a low-frequency nasal formant with a center frequency of about 250-500 Hz for adult males
(4) A slight increase in the F1 frequency and a slight lowering of the F2 and F3 frequencies
(5) Presence of one or more anti-formants.

26 In the second spectrogram of Illustration 9, the front unrounded vowel also shows signs of nasalization from the following palatal nasal.

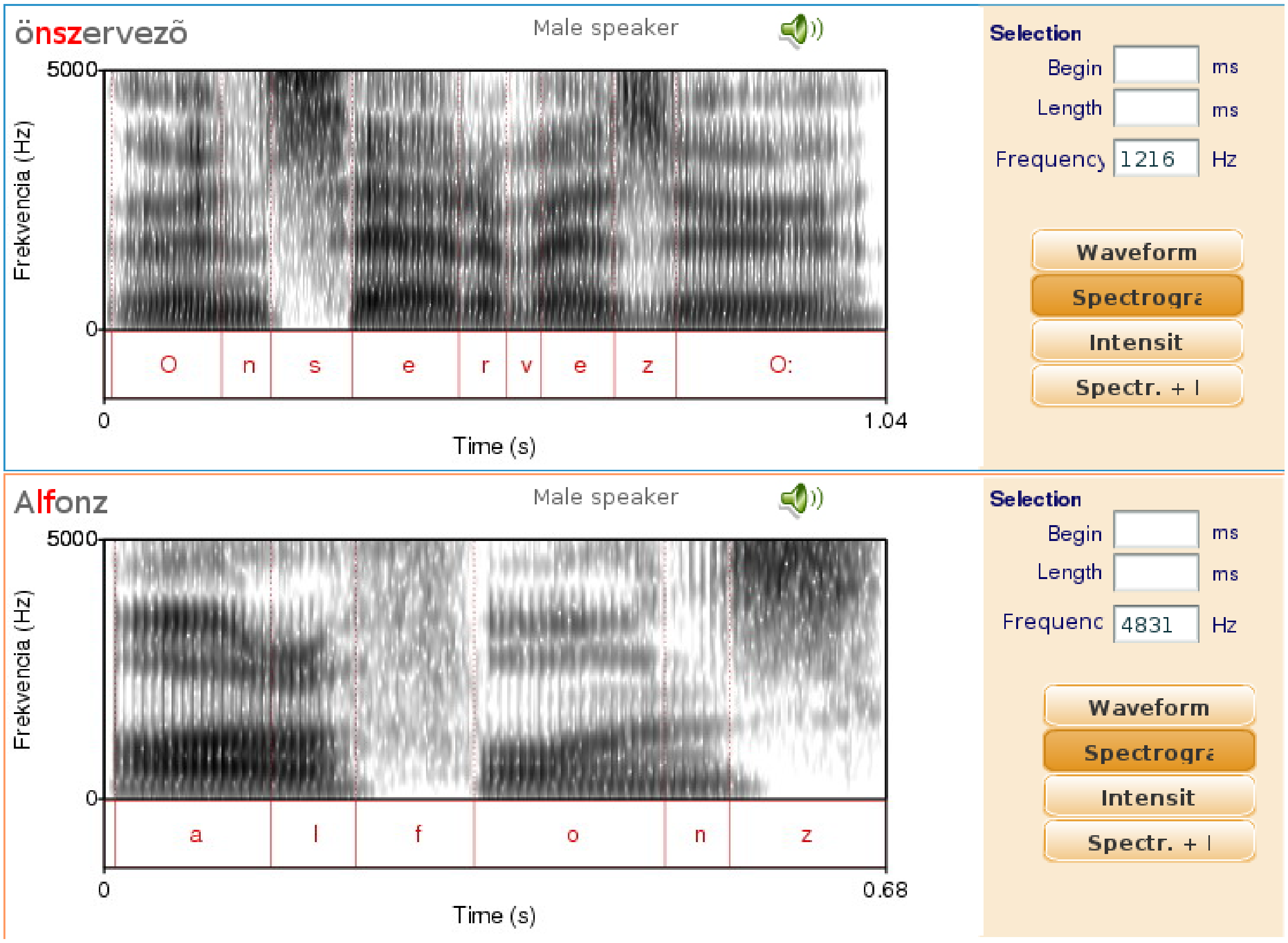

Illustration 17: Spectrograms of nasalization of the preceding vowel (Olaszy 2007). Spectrogram 1: /øns/ → [ø̃ns]. *Spectrogram 2:* /onz/ → [õnz̊].

The PSM is a fine approach to describe vowel-consonant interactions, in this case nasal coalescence (see illustration of feature spreading in Illustration 18). The first segment is specified for being a vowel, in this case, with an [open] feature on the V-manner node. The second segment is a nasal, which is shown by the [nasal] feature on C-manner. The vowel and the nasal get realized together, which yields a nasalized vowel.

The conditioning environment for the process is a continuant third segment. The [open] feature on the C-manner node captures fricatives in the PSM model of Hungarian, approximants are not shown here. The nasalization on the third segment is not included in the representation, first because the it is not so pronounced compared to the nasalization of the vowel and second because the re-association of features in both directions is not a common phenomenon and there is no received way of representing it in feature geometries.

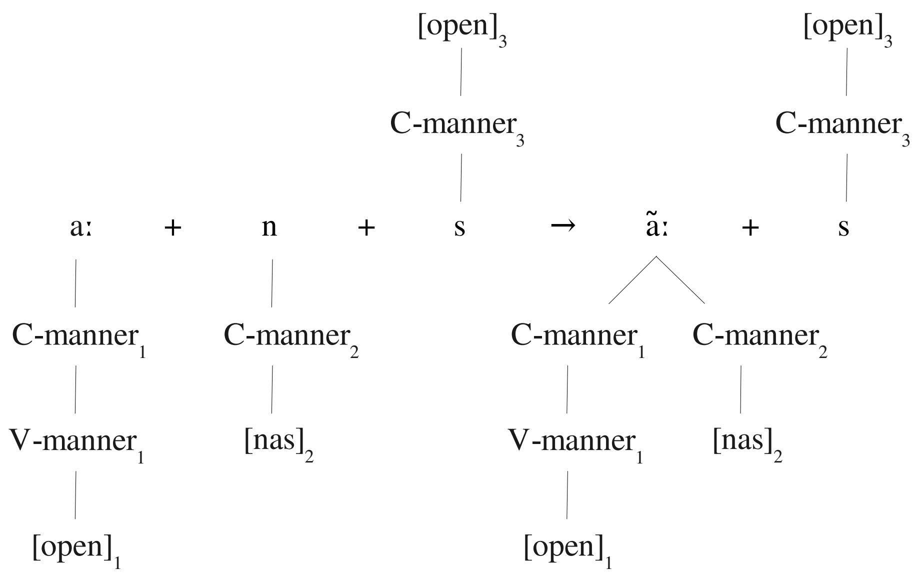

Illustration 18: PSM representation of nasal coalescence in Standard Hungarian

To sum up this section, the other nasal process of Standard Hungarian, nasal coalescence has been introduced (cf. Table 8). Instead of the distinctive featural approach, where it can only be captured in two steps (deletion of the nasal and nasalization of the vowel), I will rather regard the phenomenon a coalescence of two segments, the vowel and the nasal consonant, resulting in a nasalized vowel. I gave examples of nasal coalescence in Table 9. The spectral images taken from the Olaszy database (Illustration 17) only exhibit nasalization on the vowel, without the deletion of the nasal consonant, possibly due to carefully pronounced speech. Illustration 18 contains my analysis of the featural representation of the process in the PSM. The nasal coalescence is captured by re-associating the [nasal] feature to the C-manner of the vowel.

4.4 Realization of nasals in autistic speech

4.4.1 Singleton nasals

Production of nasals is diverse across the speakers' segment inventories. Due to extremely limited speech data, this thesis makes no attempt to generalize over the observed patterns. What can be inferred still is that all speakers' segment inventory contains the alveolar nasal in onset position (Table 10). In the examined samples, however, the labial nasal is only attested in half of the speakers (F, Z, M – Table 11) and the occurrence of palatal nasal is even more restricted (F, Z – Table 12). Evidence for the absence of the labial and palatal nasal, i. e. the process of denasalization of these phonemes complements these findings in the samples of Bandi and Pisti. They systematically realize the labial nasal as the labial oral stop and (Table 13) Bandi distorts the production of the palatal nasal by denasalization as well.

Table 10: Alveolar nasal in onset (all speakers)

UR[11]	SR[12]	ASR[27]	PhE[13]	Sample[28]	Gloss	PhP[14]	Speaker[29]
n		n	WIO[18]	*nincs*	'none'	∅	Feri
n		n	WIO	*nem*	'no'	∅	Zoli
n		n	WMO[19]	*csinál+ja*	'do' 1/3 TR	∅	Misi
n		n	WIO	*nincs*	'none'	∅	Pisti
n		n	WIO	*né(ni)*	addressing an adult female	∅	Ákos
n		n	WMO	*me(g) +néz+te*	's/he watched it'	∅	Bandi

Table 11: Labial nasal in onset (subset of speakers with alveolar nasal)

UR[11]	SR[12]	ASR[27]	PhE[13]	Sample[28]	Gloss	PhP[14]	Speaker[29]
m		m	WIO[18]	*mesé+k+be*	'in the tales'	∅	Feri
m		m	WIO	*metró*	'underground'	∅	Zoli

27 Autistic surface representation
28 Sample taken from the ASD database
29 Pseudonym of the speaker

UR[11]	SR[12]	ASR[27]	PhE[13]	Sample[28]	Gloss	PhP[14]	Speaker[29]
m		m	WIO	*meg+ (h)arap+ja*	'(it) bites it'	∅	Misi

Table 12: Palatal nasal in onset (subset of speakers with labial and alveolar nasals)

UR[11]	SR[12]	ASR[27]	PhE[13]	Sample[28]	Gloss	PhP[14]	Speaker[29]
ɲ		ɲ	WIO[18]	*nyár+ba*	'in (the) summer'	∅	Feri
ɲ		ɲː	WMO[19]	*eny+ém*	'mine'	LEN[30]	Zoli

Table 13: Denasalization of the labial nasal (B and P)

UR[11]	SR[12]	ASR[27]	PhE[13]	Sample[28]	Gloss	PhP[14]	Speaker[29]
m		b	WFC[20]	*állatom*	'my animal'	DN[31]	Bandi
m		b	WIO[18]	*meleg*	'warm'	DN	Bandi
m		b	WIO	*mi*	'what'	DN	Pisti
m		b	WIO	*mindjárt*	'soon'	DN	Pisti

Table 14: Denasalization of the palatal nasal (B)

UR[11]	SR[12]	ASR[27]	PhE[13]	Sample[28]	Gloss	PhP[14]	Speaker[29]
ɲ		j	WIO[18]	*nyer+tek*	'they won'	DN[31]	Bandi

In this section, I have shown the production of single nasals in the speech of the ASD participants. The findings are summarized in a form of Wenn-diagram in Illustration 19. Based on the ASD database, all the speakers exhibit the production of the alveolar nasal (Table 10). The outer set signifies those speakers whose phonetic inventory possess the the alveolar nasal but no other nasals. In the database I also found that Bandi denasalizes both the labial nasal (Table 13) and the palatal nasal (Table 14), plus Pisti denasalizes the labial (Table 13). Ákos did not exhibit the production of other nasals than alveolar. Misi produced the labial nasal in onsets (Table 11), which is the reason why he is in the middle set. Feri and Zoli also produced the labial nasal (Table 11), plus the palatal (Table 12), which puts them in the innermost set in the diagram.

30 Lengthening
31 Denasalization

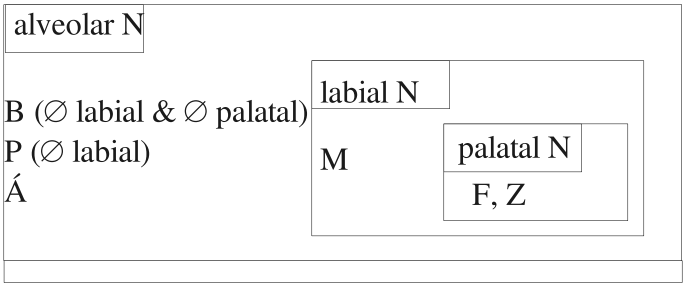

Illustration 19: Wenn-diagram – Presence of nasals across the speakers' segment inventories

4.4.2 Nasals in clusters

4.4.2.1 Nasal coalescence

Since nasals are non-syllabic in Hungarian, there is a vowel in front of every nasal-consonant cluster. In this section, I use the term “nasal-consonant cluster” generally to nasal processes and “vowel-nasal-consonant sequence” more specifically to nasal coalescence, since it also involves the preceding vowel. First, it is important to note that there is no nasal-consonant cluster in the whole database that is produced in a typical way (i.e. the way in Standard Hungarian). A fairly large amount of nasal-consonant clusters in the database are realized as nasal coalescence (see Table 22 for specific figures). Nasal coalescence in ASD speech, similarly to Standard Hungarian, occurs across phonotactic boundaries, if any. In the examined speech samples, there are four substantial modifications that can be observed in nasal coalescence. All of the modifications broaden the application range of the nasal coalescence compared to nasal coalescence in Standard Hungarian.

(1) Based on the ASD database, nasal coalescence in ASD speech is not optional (i.e. not dependent on external factors such as speech rate), but occurs across syllable, morpheme and word boundaries, cf. entries of Table 15, Table 16, Table 17 and Table 18 (exceptions are covered in 4.4.2.2).

(2) All of the nasals, not just the alveolar /n/ gets deleted in the process.[32] (e.g. the labial nasal deletes in the third entry of Table 15, the palatal in entries of Table 16)

32 That may be expected by the impartial realization of singleton labial and palatal nasals, cf. Illustration 19.

(3) Nasalization primarily targets the preceding vowel, though also leaves the adjacent consonant nasalized, up to various extents (regressive and progressive nasalization, cf. entries of Table 15, Table 16, Table 17 and Table 18).[33]

(4) The following consonant does not necessarily have to be a continuant, it can be any consonant (e.g. velar stops in the entries of Table 15).

As for nasal place assimilation (discussed in Section 4.2), since nasals in nasal-consonant clusters are realized as nasalizations on other segments, no nasal place assimilation can be observed. Tables between Table 15, Table 16, Table 17 and Table 18 detail the speakers' atypical productions sorted out by phonotactic environment (coda clusters, across syllables, morphemes and words). For the sake of convenience, the tables only contain the un-nasalized variety of vowel-nasal-consonant sequence in the case of adult surface productions.

In Table 15, the nasal coalesce in coda clusters is shown. The nasals in the first two entries are realized as a palato-alveolars and the labial nasal in the third entry surfaces unchanged in Standard Hungarian (cf. Section 4.3). In the speech samples of the autistic speech, however, all nasals are realized as nasalizations on the surrounding vowel and consonant.

Table 15: Nasal coalescence in coda clusters

UR[11]	SR[12]	ASR[27]	PhE[13]	Sample[28]	Gloss	PhP[14]	Speaker[29]
int͡ʃ	in̄t͡ʃ	ĩːt̃͜s	CCL[17]	*ni<u>ncs</u>*	'none'	COA[24]	Pisti
int͡s	in̄t͡s	ĩːt̃͜s	CCL	*Lőri<u>nc</u>*	male name	COA	Zoli
omb		õːb̃	CCL	*go<u>mb</u>*	'button'	COA	Misi

Table 16 shows essentially the same results across syllable boundary. The first three entries contain an alveolar nasal + velar consonant cluster. In the adult examples, it gets realized as a velar nasal. The fourth entry surfaces unchanged in the adult surface representation (cf. Section 4.3). The autistic speech samples are again contain nasalizations on the remaining vowel and consonant.

33 It may well be the case that in Standard Hungarian the following consonant gets also nasalized to some extent in nasal coalescence. Siptár and Törkenczy (2000) do not point that out, though some examples from the CC-cluster database (Illustration 9) indicate that there might is nasalization.

Table 16: Nasal coalescence across syllable boundary

UR[11]	SR[12]	ASR[27]	PhE[13]	Sample[28]	Gloss	PhP[14]	Speaker[29]
ɒng	ɒŋg	ɒ͠ːg̃	SCL[21]	*hang+ja*	'his/her voice'	COA[24]	Misi
ong	oŋg	o͠ːg̃	SCL	*korong+om*	'my disc'	COA	Feri
ɛng	ɛŋg	ɛ͠ːg̃	SCL	*tenger+be*	'into the sea'	COA	Bandi
und		u͠ːd̃	SCL	*Grundi(g)*	brand name	COA	Pisti

Table 17 shows nasal coalescence across morpheme boundary. The two examples contain palatal nasals. The adult speech pattern is identical to the underlying form (cf. Section 4.3). The autistic realization again conforms to nasal coalescence.

Table 17: Nasal coalescence across morpheme boundary

UR[11]	SR[12]	ASR[27]	PhE[13]	Sample[28]	Gloss	PhP[14]	Speaker[29]
eːɲk	eːɲ͡ŋk	e͠ːk̃	MCL[15]	*le+fény+kép +ez*	'(s)he makes a photo'	COA[24]	Misi
øɲvj		ø͠ːb̃ː	MCL	*könyv+jelző*	'book-marker'	COA	Bandi

Table 18 includes examples of nasal coalescence across word boundary. In the first case, the alveolar nasal assimilated to the following labial consonant, while in the second, the alveolar assimilates to the palato-alveolar consonant in the adult production (cf. Section 4.3). The ASD samples, again exhibit nasal coalescence in both of the examples given.

Table 18: Nasal coalescence across word boundary

UR[11]	SR[12]	ASR[27]	PhE[13]	Sample[28]	Gloss	PhP[14]	Speaker[29]
ɛnb	ɛmb	ɛ͠ːb̃	WCL[22]	*tükör+ben#B alázs*	B. (name) 'in the mirror'	COA[24]	Misi
int͡ʃt	in̄t͡ʃ	i͠ːt̃	WCL	*nincs#több*	'no more'	COA	Feri

Illustration 20 is a feature geometric summary of nasal coalescence in autistic speech. For convenience, the place nodes are placed above, the manner nodes are placed below their segments. The first segment is a front unrounded vowel, which is mapped to the feature geometric structure as [coronal] feature specification on the Vowel-place node (cf. the vowel chart in the PSM in Section 8.2). The second pre-consonantal nasal is underlyingly specified for place as a [coronal] and for manner as a nasal (Section 8.2 contains the PSM chart for consonants). The first and the second segment fuses on the surface. The place specification of the nasal de-links (cf. point (2) in the beginning of this section).

The conditioning environment can be any consonant that follows the nasal, in this particular case it is a velar plosive, which is specified for being [dorsal] on the C-place node and for [closed] on the C-manner node (the PSM consonant chart is given in Section 8.2). The nasalization on the third segment is again not represented for reasons already mentioned in Section 4.3.

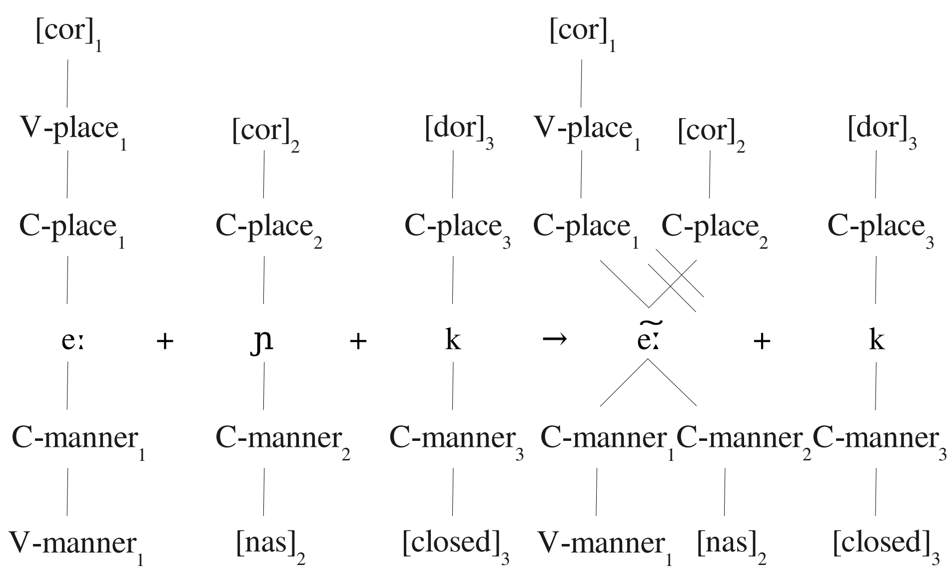

Illustration 20: PSM representation of nasal coalescence in autistic speech

All in all, this section introduced the nasal coalescence in the autistic speech, relying on the entries of the ASD database. It outlined four differences between the application range of between nasal coalescence in the speech samples and in the standard variety of Hungarian (it occurs exceptionlessly, in every vowel-nasal-consonant sequence, plus nasalization is apparent also on the consonant). The four tables show some ASD speech samples of nasal coalescence in various phonotactic positions (in coda cluster, across syllable, morpheme and word boundary).

4.4.2.2 Other processes involving nasal-consonant clusters

Long distance assimilation is attested in all of the informants' speech, mostly in the form of long distance nasalization; moreover, the speech of five speakers (except Ákos) is full of examples. Long distance assimilation is not accounted for in the thesis. Relevant samples are not included here, only given in Section 8.1.

Nasal coalescence and nasal place assimilation can only be attested in those speakers whose speech contain consonant clusters. Since Ákos hardly leaves syllables unrepaired with respect to the phonotactic requirements, consonant clusters and, therefore, nasal-consonant clusters are scarce in his speech. The only sample of nasal-consonant cluster that I found in his speech is underlyingly a labial nasal-consonant cluster. Ákos produces this cluster applying nasal place assimilation. Thus, the labial nasal turns to an palato-alveolar before the palato-alveolar affricate (shown in Table 19).

Table 19: Realization of nasals in clusters (only Á)

UR[11]	SR[12]	ASR[27]	PhE[13]	Sample[28]	Gloss	PhP[14]	Speaker[29]
omt͡ʃ		on̠t͡ʃ	MCL[15]	*T<u>om+cs</u>i*	T. male name DIM	POA[16]	Ákos

Bandi, on the other hand, realizes the nasal in clusters in two ways. Apart from nasal coalescence (covered in Section 4.4.2.1), there is a sample which contains an alveolar nasal – alveolar consonant cluster and realized as a palatal nasal-palatal consonant (a process known as backing). shown in Table 20).

Table 20: Realization of nasals in clusters (only B)

UR[11]	SR[12]	ASR[27]	PhE[13]	Sample[28]	Gloss	PhP[14]	Speaker[29]
ont		oɲc	SCL[21]	*cs<u>ont</u>+ok*	'bone' PL	BAC[34]	Bandi

Feri's production of nasal-consonant clusters either results in full or partial assimilation of segments. Note that in all of the samples the second member of the cluster is the labiodental fricative which does trigger assimilation (as shown in 4.2) in Standard Hungarian; although, only with labial and alveolar nasals.

Table 21 shows Feri's production of nasals plus the labiodental fricative. In Standard Hungarian, no process takes place in the first entry and in the second and third the nasal assimilates to the

34 Backing is a phonological process in which a segment is substituted by another produced more backwards in the vocal tract.

labiodental (see Section 4.3). In Feri's production, the first entry shows the place of assimilation of the palatal nasal to the labiodental consonant. In the other two entries, both the labial and the alveolar nasal completely fuses with the labiodental fricative. Regarding the cluster of palatal nasal + labiodental, the sample by Feri shows nasal place assimilation.

Table 21: Realization of nasals in clusters (only F)

UR[11]	SR[12]	ASR[27]	PhE[13]	Sample[28]	Gloss	PhP[14]	Speaker[29]
øɲv		øɱv̥	SCL[21]	*könyv+em+be*	'book' LOC POSS	DV[35]	Feri
ønv	øɱv	øm:	MCL[15]	*kölcsön+vehet+em*	'can I borrow'	COA[24]	Feri
ɛmv-n	ɛɱv	ɛm:	WFC[20]	*neke+m#van*	'I have'	COA	Feri

The remaining speakers Misi, Pisti and Zoli exhibit no other process involving nasal-consonant clusters than nasal coalescence (discussed in 4.4.2.1) and long distance assimilation (only to be listed in 8.1). Table 22 provides a summary of the phonological processes that take place in nasal-consonant clusters (nasal coalescence percentages in bold), with speakers ordered by age. Note that these data are definitely suggestive, though only reflect the production of six ASD children.

Table 22: Phonological processes in vowel-nasal-consonant sequences (long distance assimilation excluded, percentages of nasal coalescence in bold)

Speaker	Phonological process	Number of occurrences in the ASD database	%
Misi	nasal coalescence	13	**100**
Bandi	nasal coalescence	4	**80**
	backing	1	20
Pisti	nasal coalescence	5	**100**
Zoli	nasal coalescence	2	**100**
Ákos	nasal place assimilation	1	100
Feri	nasal coalescence	4	**57**
	coalescence	2	29
	nasal place assimilation	1	14

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In sum, this section highlighted the processes other than nasal coalescence in nasal-consonant clusters in the speech samples of the ASD database. Together with the section on nasal coalescence, Table 22 concludes that

(1) nasal coalescence is the most prevalent process, considering vowel-nasal-consonant sequences

(2) five out of six children exhibits nasal coalescence, three of them without exception and two at a relatively high prevalence rate (80%, 57%)

Table 19 gives the sample of nasal place assimilation, Ákos's only relevant sample. Table 20 contains the sample of backing by Bandi. Table 21 comprises the production of nasal – labiodental custers of Feri. The other three children – Misi, Pisti and Zoli, as said, only exhibit nasal coalescence.

5 Processes involving obstruents

This chapter turns to phonological processes that affect obstruents, more specifically, voicing assimilation in Standard Hungarian (Section 5.1) and in ASD speech (Section 5.3) and voicing and devoicing in ASD speech (Section 5.2).

5.1 Voicing assimilation in Standard Hungarian

In Hungarian, no different voicing values for adjacent obstruents are tolerated. Every obstruent triggers and undergoes voicing assimilation in every phonotactic environment unless a pause intervenes. Sonorants do not participate in voicing assimilation.

The outcome of voicedness is determined by the rightmost member in the cluster (regressive assimilation). It is operative across morpheme and word boundaries (see Table 23 and Table 24, spectrograms in Illustration 21). The examples in Table 25 show the iterativity of voicing assimilation (related spectrograms in Illustration 22).

Table 23, Table 24 and Table 25 each contain a pair of examples. The first entry shows the voicing and the second entry the devoicing in voicing assimilation in order to illustrate the symmetricity of bidirectionality of voicing assimilation.

Table 23 is an example for voicing assimilation across morpheme boundary. The first entry contains a voiceless + voiced cluster underlyingly. In adult speech, it gets realized as two voiced segments. The second entry is the mirroring image of the first. It is a voiced + voiceless cluster, which surfaces as voiceless + voiceless due to voicing assimilation.

Table 23: Voicing assimilation across morpheme boundary

UR[11]	SR[12]	PhE[13]	Sample	Gloss	PhP[14]
pd	p̌d	MCL[15]	*né<u>p+d</u>al*	'folk song'	VA[36]
bt	b̥t	MCL	*do<u>b+t</u>ető*	'drum top'	VA

Illustration 21 contains the spectrograms of the two entries. In the first spectrogram, some

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residual voicing is visible on the devoiced plosive, which is partly segmented to the preceding vowel.

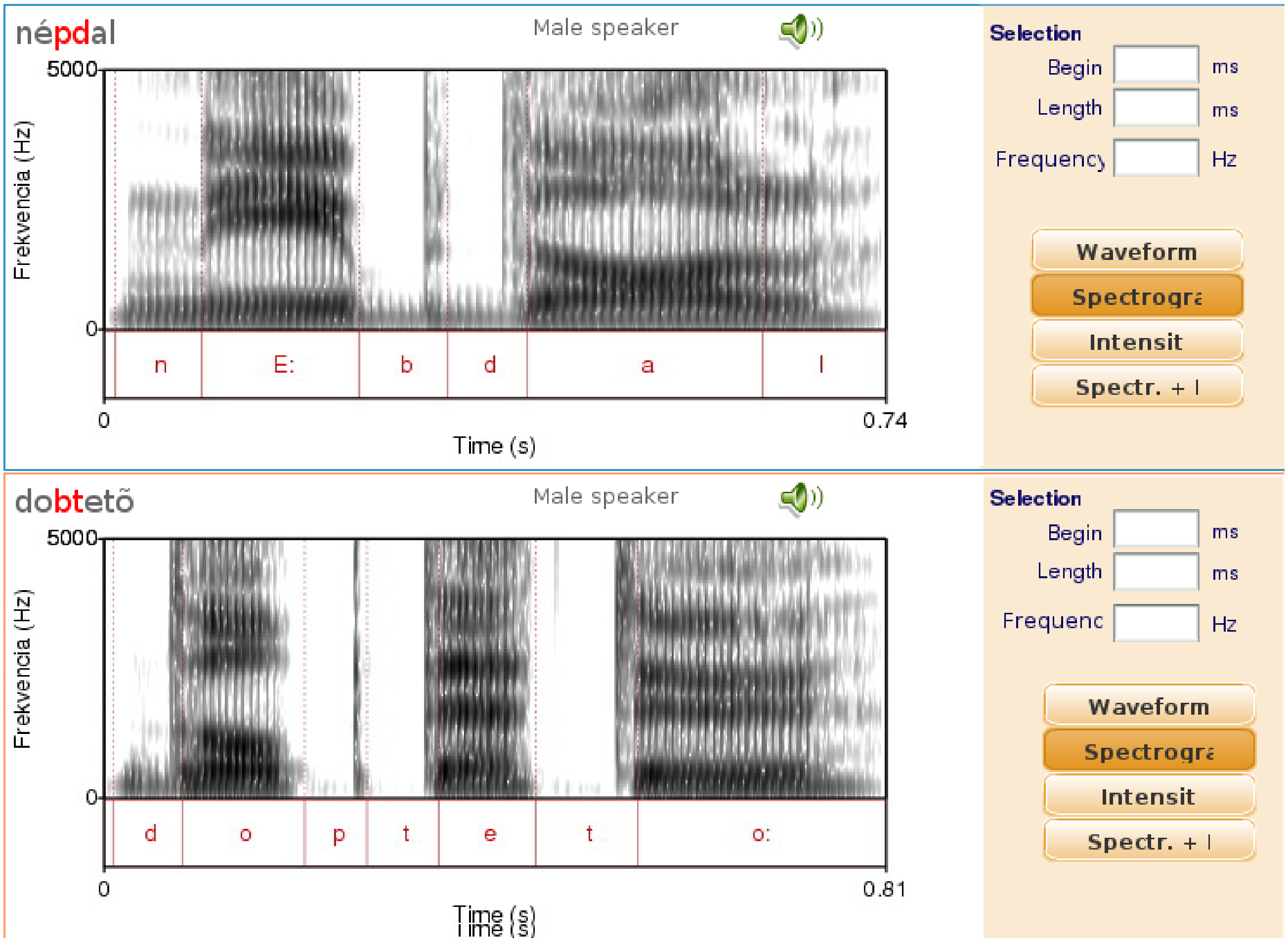

Illustration 21: Spectrograms of voicing assimilation in CC clusters (Olaszy 2007). Spectrogram 1: /pd/ → [p̌d]. *Spectrogram 2:* /bt/ → [b̥t].

Table 24 shows voicing assimilation across word boundary. In parallel to the entries of the previous table, the first entry provides an example of voicing and the second is an example of devoicing. The voiceless + voiced cluster in the second entry comes out as voiced + voiced on the surface and the voiced + voiceless cluster is realized as voiceless + voiceless. There are no spectrograms for these examples, because the Olaszy database only contains single words.

Table 24: Voicing assimilation across word boundary

UR[11]	SR[12]	PhE[13]	Sample	Gloss	PhP[14]
pɟ	p̌ɟ	WCL[22]	*kap#gyógyszert*	's/he get medicine'	VA
dt	d̥t	WCL	*ad#tortát*	's/he gives cake'	VA

The iterativity of the voicing assimilation is shown by Table 25. The first entry contains two voiceless plus a voiced segments in the underlying representation. It turns into a voiced + voiced + voiced cluster on the surface. In the second entry, it is the opposite pattern: the two voiced segment turns into voiceless in front of a voiceless segment.

Table 25: Iterativity of voicing assimilation

UR[11]	SR[12]	PhE[13]	Sample	Gloss	PhP[14]
stb	s̬t̬b	MCL[15]	*búza+liszt+ből*	'from wheat flour'	VA
zdt	z̥d̥t	MCL	*ki+kezd+ték*	'they made pass on him/her'	VA

The first spectrogram in Illustration 22 shows the partial voicing of the two voiceless segments in front of a voiced segment (the second plosive is also spirantized). The two voiceless segments in the second spectrogram are completely devoiced in front of a voiceless alveolar. Note that the voiceless alveolar plosives are realized together.

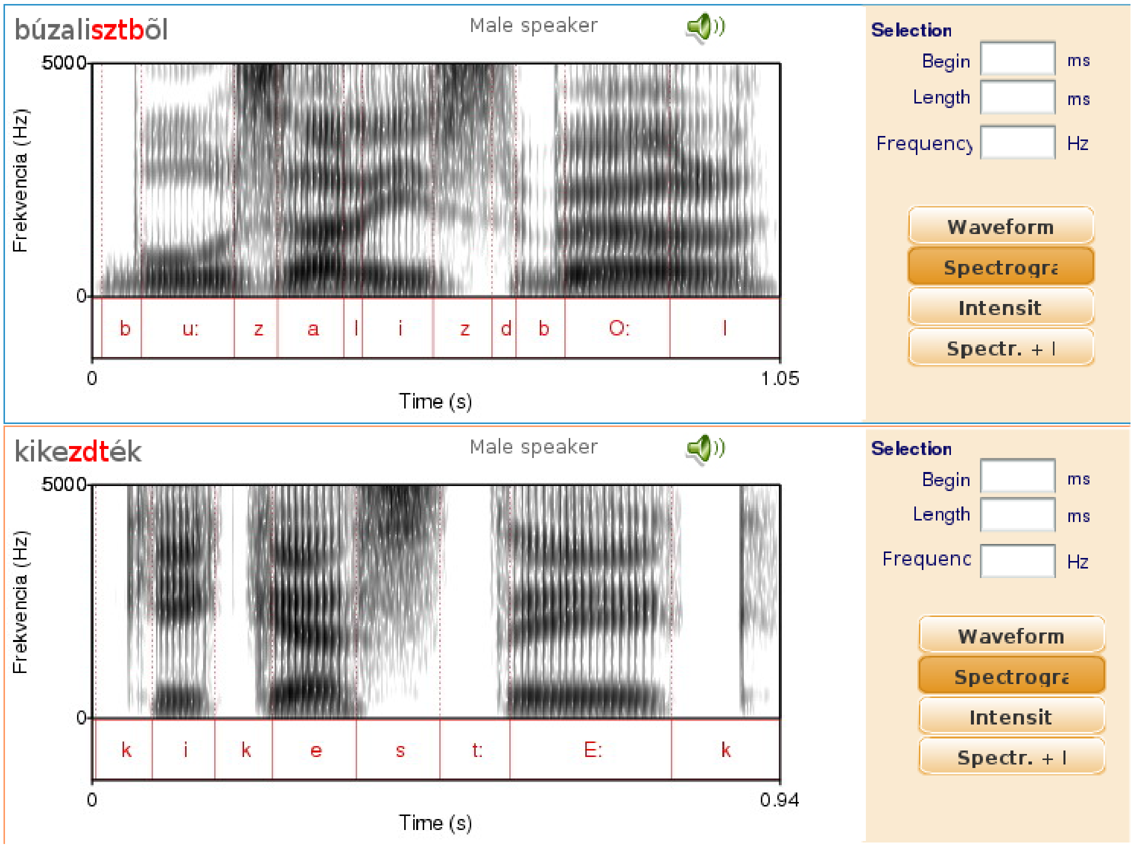

Illustration 22: Spectrograms of voicing assimilation in CCC clusters (Olaszy 2007). Spectrogram 1: /stb/ →[s̬t̬b]. *Spectrogram 2:* /zdt/ → [z̥d̥t].

So far, I have shown that voiced obstruents make the preceding consonants voiced and voiceless obstruents make the preceding consonants voiceless. Also, voiced obstruents undergo devoicing when followed by voiced obstruents and voiceless obstruents undergo voicing when followed by voiced ones.

Traditionally, two sounds, the voiced labiodental /v/ and the voiceless velar /h/ are exceptions from this pattern of voicing assimilation. In the description of Siptár and Törkenczy (2000), the voiced labiodental fricative does *not* trigger voicing assimilation in C/v/ contexts (cf. first entry of Table 26), albeit it undergoes devoicing in /v/C clusters (cf. second entry of Table 26).

Table 26: Voicing assimilation of /v/: *makes no devoicing in* C/v/, *but undergoes devoicing in* /v/C.

UR[11]	SR[12]	PhE[13]	Sample	Gloss	PhP[14]
tv	tv	MCL	*át+vezet*	's/he drives through'	∅

UR[11]	SR[12]	PhE[13]	Sample	Gloss	PhP[14]
vt	v̥t	MCL[15]	*év+től*	'from the year'	VA

The spectral images in Illustration 23 support this statement. The first image shows the devoicing of the /v/ in front of a voiceless plosive and the second image does not show the voicing of alveolar followed by /v/.

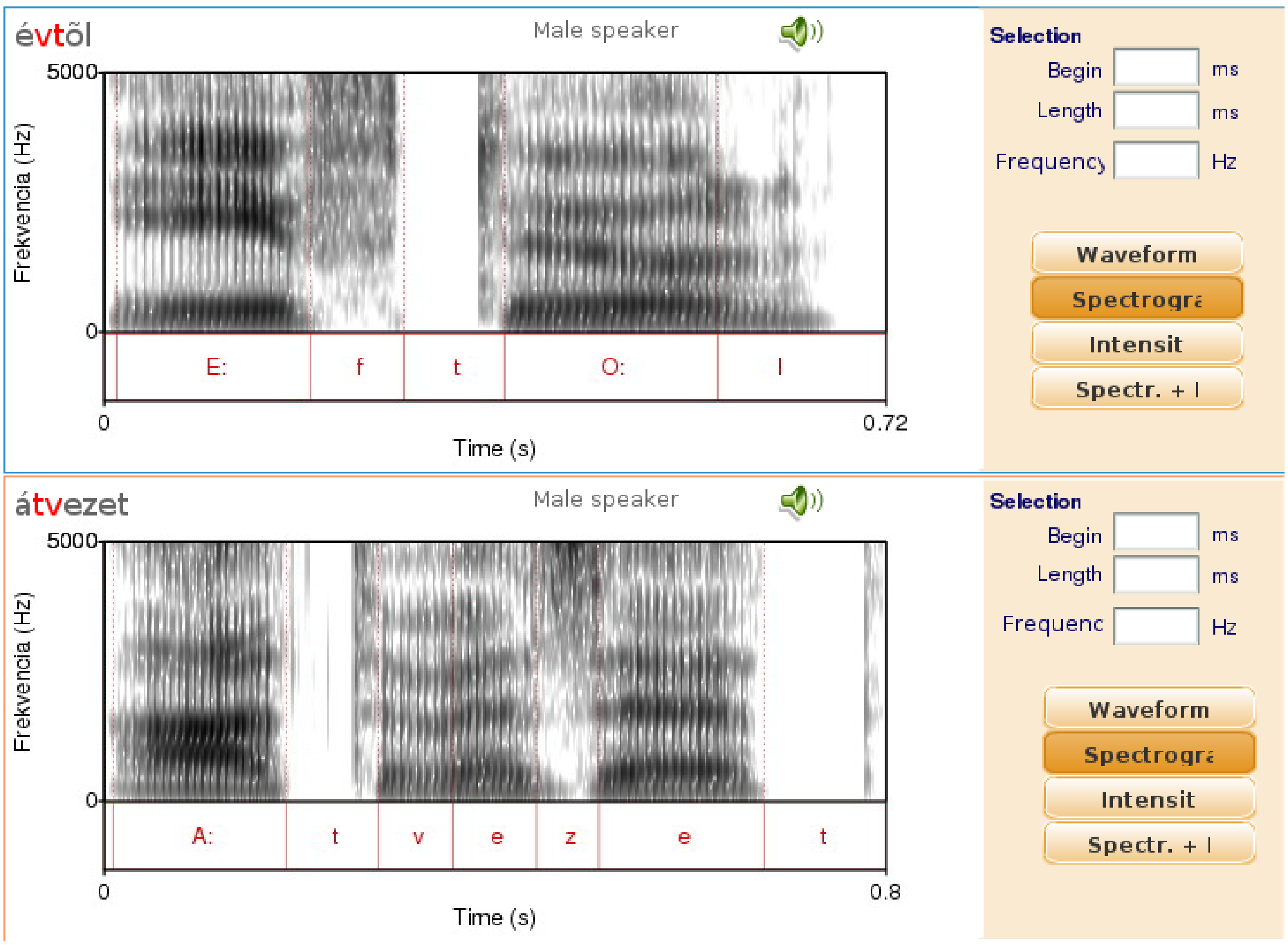

Illustration 23: Spectrograms of voicing assimilation in clusters containing /v/ *(Olaszy 2007). Spectrogram 1:* /vt/ → [v̥t], *spectrogram 2:* /tv/ → [tv].

The second exception is the velar phoneme /h/. According to Siptár and Törkenczy (2000), it also behaves exceptionally. Although, it exhibits a pattern opposite to the one of /v/. Despite of not undergoing voicing in /h/C environment (first entry in Table 27), /h/ leads to the devoicing of the obstruent in C/h/ sequences (second entry of Table 27).

Table 27: Voicing assimilation of /h/*: no voicing in* /h/C*, but causing devoicing in* C/h/

UR[11]	SR[12]	PhE[13]	Sample	Gloss	PhP[14]
hd	hd	SCL[21]	*a<u>hd</u>a*	nonsense word	∅
zh	z̥h	MCL[15]	*há<u>z+h</u>ely*	'place of the house'	VA

Indeed, the first spectral image in Illustration 22 shows not full, only slight voicing for /h/ when followed by a voiced obstruent. The second image shows the full devoicing of the alveolar fricative when followed by /h/.

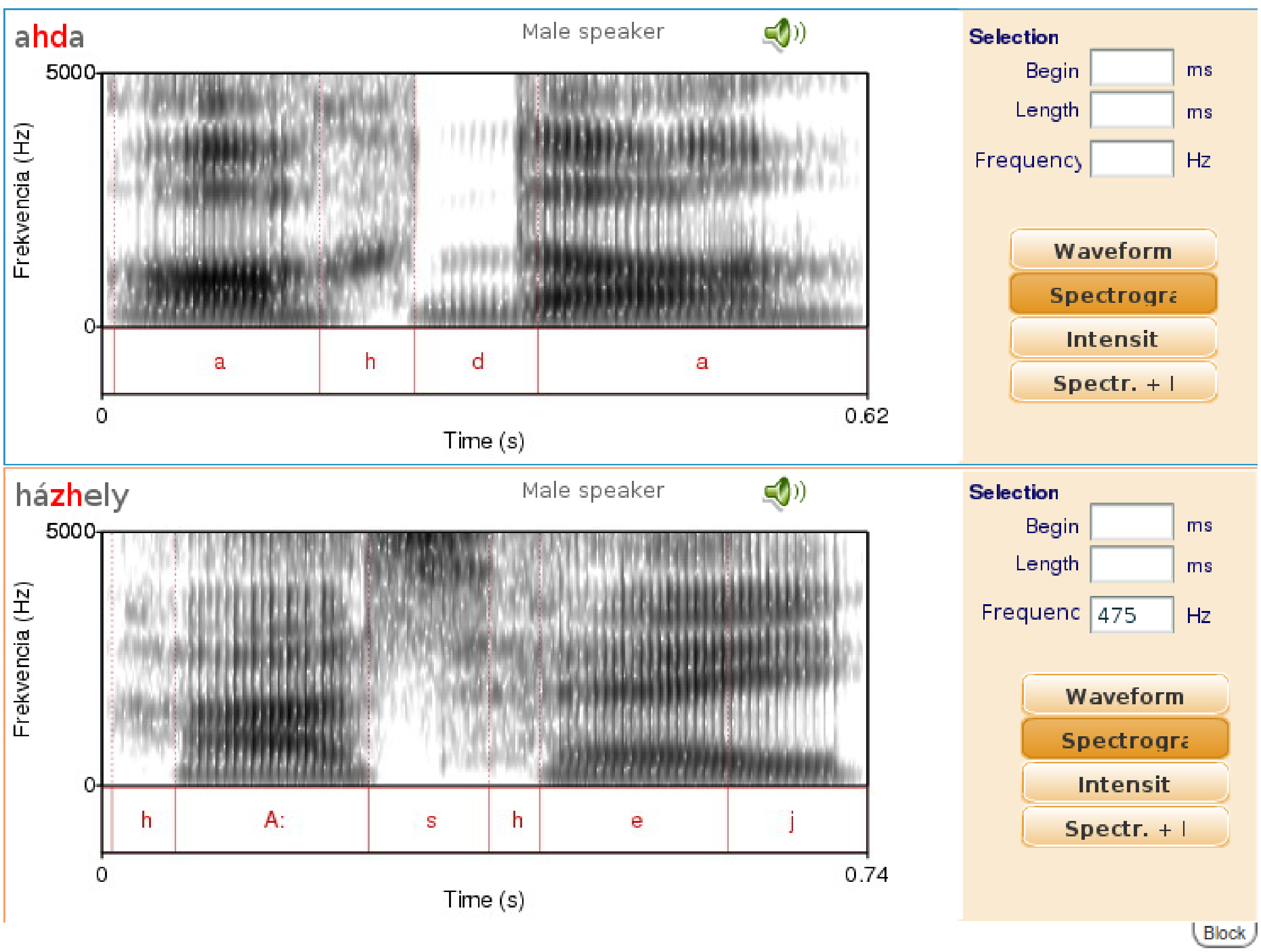

Illustration 24: Spectrograms of voicing assimilation in clusters containing /h/ *(Olaszy 2007). Spectrogram 1:* /hd/ → [hd]. *Spectrogram 2:* /zh/ →[z̥h].

In this section, I have introduced voicing assimilation in Standard Hungarian. I have shown that in general

(1) all obstruents are able to trigger voicing assimilation in the preceding obstruent (cf. Table 23, Table 24 for examples and Illustration 21 for spectrograms).

(2) all obstruents are subject to changing their voicing values in accordance with the voicing value of the rightmost member in an obstruent cluster (again, cf. Table 23, Table 24 for examples and Illustration 21 for spectrograms).

I have also shown that the voicing assimilation is iterative. (see Table 23 and Table 24, spectrograms in Illustration 22). However, there are two exceptions to the process. /v/ undergoes voicing assimilation but does not trigger it (examples in Table 26, spectrograms in Illustration 23) and /h/ does not undergoes voicing assimilation but does trigger it (examples in Table 27, spectrograms in Illustration 22).

5.2 Voicing disturbances in autistic speech

5.2.1 Devoicing

In Section 2.1, I made a distinction between developmental and non-developmental phonological processes.

Among the ASD participants, onset devoicing is the most frequent among the voicing processes, considering both inter and intra-speaker databases (summaries of the processes are given in Table 37 and Table 41).

The production of the obstruents is remarkable in Feri's speech. Speech samples from Feri in the database suggest that he realizes obstruents as voiceless, regardless of position or underlying voicing value, as the following entries in Table 28-Table 33 indicate. It might be the case that Feri makes no phonemic distinction between voiced and voiceless obstruents, but I would need more samples to confirm that.

Table 28-Table 33 contain all samples of Feri's devoicing that could be found in the database.[37]

37 Whether sonorants preserve their voicing in various phonotactic positions or not could only be determined by phonetic

In all of the samples, adult surface representation (SR) is identical to the underlying representation, therefore not repeated (cf. Section 3.2).

Developmental and non-developmental devoicing processes are kept separate. Non-developmental processes are shown in Table 28 and Table 29, (devoicing in onset positions) and in Table 30 and Table 31 (devoicing in consonant clusters across syllable and morpheme boundary). Developmental processes are included in Table 32 and Table 33 (devoicing in coda cluster and word-final coda).

Table 28 lists all the word-initial onsets, that have been devoiced, by Feri. All entries contain plosives. The first two entries contain the labial, the third and the fourth entries the alveolar and the last entry the velar plosive.

Table 28: Devoicing in word-initial onsets (only F)

UR[11]	SR[12]	ASR[27]	PhE[13]	Sample[28]	Gloss	PhP[14]	Speaker[29]
b		b̥	WIO[18]	*Barnus*	male name	DV[35]	Feri
b		b̥	WIO	*Botond*	male name	DV	Feri
d		d̥	WIO	*de*	'yet'	DV	Feri
d		d̥	WIO	*doboz*	'box'	DV	Feri
g		g̊	WIO	*Gergő*	male name	DV	Feri
z		z̥	WIO	*zöld*	'green'	DV	Feri

Table 29 is a list of word-medial onsets, that have been devoiced again, by Feri. The entries contain the labial, the alveolar, the velar and the palatal plosives, respectively.

Table 29: Devoicing in word-medial onsets (only F)

UR[11]	SR[12]	ASR[27]	PhE[13]	Sample[28]	Gloss	PhP[14]	Speaker[29]
b		b̥	WMO[19]	*doboz*	'box'	DV[35]	Feri
d		d̥	WMO	*madar+ak*	'bird' PL	DV	Feri
g		g̊	WMO	*Gergő*	male name	DV	Feri
ɟ		ɟ̊	WMO	*nagyon*	'very'	DV	Feri

analysis of the samples. The quality of the recordings did not allow proper phonetic analysis of present data. In the future, I aim to record in such a quality that makes spectrograms possible.

Table 30 shows the only example of devoicing across syllable boundary by Feri. Whether the sonorant preserve its voicing or not I could not determine due to the quality of the recordings. Note that the sonorant undergoes nasal place assimilation (already discussed in Section 4.4.2.2).

Table 30: Devoicing across syllable boundary (only F)

UR[11]	SR[12]	ASR[27]	PhE[13]	Sample[28]	Gloss	PhP[14]	Speaker[29]
ɲv		ɱv̥	SCL[21]	*könyv+em+be*	'book' LOC POSS	DV[35]	Feri

Table 31 contains every example of devoicing across morpheme boundary by Feri. The general pattern is that every obstruent gets devoiced. Even when adult speech would exhibit voicing through voicing assimilation (the last three entries), samples from Feri contain devoiced clusters regardless. In addition to devoicing, the fifth entry also contains nasalization of the obstruent + sonorant cluster (cf. nasal coalescence in ASD speech in Section 4.4.2.1)

Table 31: Devoicing across morpheme boundary (only F)

UR[11]	SR[12]	ASR[27]	PhE[13]	Sample[28]	Gloss	PhP[14]	Speaker[29]
zd		z̥d̥	MCL[15]	*csúz+da*	'slide'	DV[35]	Feri
zd		z̥d̥	MCL	*csúz+dáz+tam*	'I played on the slide'	DV	Feri
zː		z̥ː	MCL	*kérd+ez+zek*	'(what) I ask' IND	DV	Feri
rb		rb̥	MCL	*nyár+ba*	'in (the) summer'	DV	Feri
ɲvr		v̥͠r	MCL	*könyv+re*	'on (the) book'	DV	Feri
mb		mb̥	MCL	*könyv+em+be*	'book' LOC POSS	DV	Feri
lz		lz̥	MCL	*könyv+jel+ző+jük*	'their bookmarker' POSS	DV	Feri
ɟm		ɟ̊m	MCL	*egy+más*	'other'	DV	Feri
ksb	k̬s̬b	kb̥	MCL	*Minimax+ba*	'on M.' (cartoon	DV	Feri

UR[11]	SR[12]	ASR[27]	PhE[13]	Sample[28]	Gloss	PhP[14]	Speaker[29]
					channel)		
kb	k̬b	kb̥	MCL	*mesé+k+be*	'in the tales'	DV	Feri
dn	d̚n	t:	MCL	*tud+nád*	'you could'	DV	Feri

Coda devoicing is a developmental process, thus expected from child language (cf. Bowen 1998 and Section 2.1). The remaining tables (Table 32 and Table 33) exhibit the speech samples of Feri where devoicing can be attested in codas.

Table 32 contains the codas in word-final position, that have been devoiced, produced by Feri. Note that the voiced alveolar fricative in the third row is realized as a labiodental, which indicates another developmental process, namely fronting (Bowen 1998).

Table 32: Devoicing in word-final coda (only F)

UR[11]	SR[12]	ASR[27]	PhE[13]	Sample[28]	Gloss	PhP[14]	Speaker[29]
d		d̥	WFC[20]	*tud+nád*	'you could'	DV[35]	Feri
z		z̥	WFC	*doboz*	'box'	DV	Feri
z		f	WFC	*ez#itt*	'this here'	DV	Feri
ɟ		ɟ̊	WFC	*vagy*	'(you) are'	DV	Feri
d		d̥	WFC	*tudod*	'you can'	DV	Feri

Table 33 contains the only instance where Feri produced a coda cluster. Again, the underlyingly voiced obstruent in coda position is realized as devoiced.

Table 33: Devoicing in coda cluster (only F)

UR[11]	SR[12]	ASR[27]	PhE[13]	Sample[28]	Gloss	PhP[14]	Speaker[29]
nd		nd̥	CCL[17]	*Botond*	male name	DV[35]	Feri

Besides Feri, Misi also exhibits non-developmental devoicing across word boundaries. All obstruent-obstruent clusters, regardless of their underlying voicing value, surface as voiceless (shown in

Table 34). The first entry shows that in adult language, the voicing of the first member of the cluster is expected. Misi, however, devoices all obstruents in all of the four entries. Note the fronting of the palato-alveolar /ʃ/ in the second entry.

Table 34: Devoicing across word boundary (only M)

UR[11]	SR[12]	ASR[27]	PhE[13]	Sample[28]	Gloss	PhP[14]	Speaker[29]
kb	k̆b	kb̥	WCL[22]	*rak+juk#be*	'let's put it inside'	DV[35]	Misi
ʃv		sv̥	WCL	*ügyes#vol+t*	'that was clever/skilful'	DV	Misi
ɟb		ɟ̊b̥	WCL	*egy#beteg+ség+et*	'a disease' ACC	DV	Misi
zv		ɟ̊v̥	WCL	*ez#val+ó*	'this fits'	DV	Misi

There are quite a few examples of developmental devoicing, too, in Misi's speech. Namely, in every word-final coda, the obstruents get devoiced. Moreover, in the last entry the production of the /z/ is distorted.

Table 35: Devoicing in word-final codas (only M)

UR[11]	SR[12]	ASR[27]	PhE[13]	Sample[28]	Gloss	PhP[14]	Speaker[29]
d		d̥	WFC[20]	*elő+vesz+ed*	'you take it out for me'	DV[35]	Misi
ɟ		ɟ̊	WFC	*egy*	'one'	DV	Misi
z		z̥	WFC	*ez*	'this'	DV	Misi
d		d̥	WFC	*el+kap+od*	'you catch it'	DV	Misi
g		g̊	WFC	*ég#a#gyertya#ég*	'the candle is burning burning'	DV	Misi
g		g̊	WFC	*ég*	'burn' V	DV	Misi
z		c	WFC	*ez*	'this'	DV	Misi

With the exception of Bandi, plus the abovementioned participants Feri and Misi, the other speakers exhibit only developmental devoicing patterns (i.e. devoicing in the word-final coda). These examples are listed in the Appendix. Bandi's sample of devoicing, however, is across a morpheme boundary (Table 36). In adult production, the process would be progressive voicing (shown in SR in Table 36, typical voicing assimilation addressed in section 5.1).

Table 36: Devoicing across morpheme boundary

UR[11]	SR[12]	ASR[27]	PhE[13]	Sample[28]	Gloss	PhP[14]	Speaker[29]
sb	s̬b	sb̥	MCL[15]	*kis+baba*	'small baby'	DV[35]	Bandi

Table 37 provides a summary of the devoicing patterns for all participants and for the section as well. Coda positions, where developmental devoicing may occur, (coda cluster – CCL, word-medial coda – WMC and word-final coda – WFC[20]) are indicated by shaded cells. Speakers are ordered by age. As shown, the most frequent process is coda devoicing in the word-final position (the column headed by WFC). Pisti, Zoli and Ákos only produced word-final coda devoicing (1, 2 and 1 examples, are found, respectively).

Speakers Feri, Misi and Bandi and produce unusual, non-developmental devoicing patterns. Feri's speech contains the most non-developmental examples. He devoices not just in word-initial and word-medial onsets (Table 28 and Table 29), but also across syllable boundary (Table 30) and morpheme boundary (Table 31). Besides, he also produces developmental devoicing in the coda cluster and in the word-final coda (Table 32 and Table 33). Table 38 contains Misi devoices every obstruent in word-final coda (Table 35) and also in clusters across the word boundary (Table 34). Table 36 shows Bandi's example of devoicing across the morpheme boundary.

Table 37: Developmental (shaded area) and non-developmental devoicing processes in the ASD database

Speaker	OCL[38]	WIO[18]	WMO[19]	CCL[17]	WMC[39]	WFC[20]	SCL[21]	MCL[15]	WCL[22]
Misi						7			4
Bandi								1	
Pisti						1			
Zoli						2			

38 Onset cluster
39 Word-medial coda

Speaker	OCL	WIO[18]	WMO[19]	CCL[17]	WMC	WFC[20]	SCL[21]	MCL[15]	WCL[22]
Ákos						1			
Feri		6	4	1		5	1	11	

5.2.2 Voicing

As I mentioned in the previous section, there are not many examples for voicing in general and non-developmental voicing in particular. In the ASD database, there are only tree non-developmental voicing processes, two produced by Bandi and one by Misi.

The first instance of voicing that I found in Bandi's speech is the voicing of the affricate + plosive cluster, shown in Table 38.

Table 38: Voicing across syllable boundary (only B)

UR[11]	SR[12]	ASR[27]	PhE[13]	Sample[28]	Gloss	PhP[14]	Speaker[29]
t͡sk		t̬͡s̬k̬	SCL	*palack+orr +ú*	'bottlenose' adj.	V	Bandi

Table 39 shows the second example of non-developmental voicing in the speech sample of Bandi. The alveolar plosive gets voiced in the word final coda cluster, preceded by a sonorant.

Table 39: Voicing in coda cluster (only B)

UR[11]	SR[12]	ASR[27]	PhE[13]	Sample[28]	Gloss	PhP[14]	Speaker[29]
t		t̬	CCL	*siker+ül+t*	'succeeded'	V	Bandi

Table 40 contains an example for non-developmental voicing by Misi. The velar plosive is in the word-medial coda and is realized as voiced.

Table 40: Voicing in word-medial coda (only M)

UR[11]	SR[12]	ASR[27]	PhE[13]	Sample[28]	Gloss	PhP[14]	Speaker[29]
k		k̬	WMC	*rak+juk#be*	’let’s put it inside’	V	Misi

There are five developmental voicing processes in the ASD database (two by Bandi and one each by Misi, Zoli and Feri). These examples are not detailed here, only their figures are given in the summarizing table, Table 41 (and included in the Appendix).

Table 41 summarizes the voicing patterns of the speakers. Developmental errors (in this case, voicing in the onset) are shaded out here, similarly to Table 37. When comparing voicing to devoicing, two remarks immediately come to mind. First, voicing is not a dominant process for none of the speakers and in none of the phonotactic positions, let it be developmental or non-developmental. Second, there is only three examples for a non-developmental voicing process in the whole corpus (i.e. voicing across syllable boundary by Bandi – Table 38, voicing in the coda cluster by Bandi – Table 39 and voicing in word-medial coda by Misi Table 40) as opposed to the twenty-seven non-developmental devoicing ones.

As mentioned, the Misi, Zoli and Feri produce one developmental voicing each. Zoli makes a voiceless obstruent voiced in the word-initial onset and Misi and Feri in the word-medial onset. Bandi produces two developmental voicing process, one in the onset cluster and one word-initially.

Table 41: Developmental (shaded area) and non-developmental voicing processes in the ASD database

Speaker	OCL[38]	WIO[18]	WMO[19]	CCL[17]	WMC[39]	WFC[20]	SCL[21]	MCL[15]	WCL[22]
Misi			1		1				
Bandi	1	1		1			1		
Pisti									
Zoli		1							
Ákos									
Feri			1						

5.3 Voicing assimilation in autistic speech

I have shown that voicing assimilation in Standard Hungarian (1) operates backwards and (2) is completely symmetrical in a sense that depending on the voicing value of the rightmost member, the preceding members become voiced or voiceless accordingly (see Section 5.1).

Figures in Table 42, Table 43 and Table 44 show examples of voicing assimilation in the coda cluster and across morpheme boundary, including all relevant examples from the speakers. Accordingly, all adult speech samples show devoicing of the first member of the cluster.

However, what can be generally seen from the autistic production with respect to voicing assimilation is that it only exhibits devoicing in the appropriate obstruent-obstruent contexts (+O[40] –O[41] → –O +O), but no voicing (–O[41] +O[40] ↛ +O +O). Table 31, Table 34 and Table 36 contain entries where the adult production would result in voicing of the obstruent, due voicing assimilation. All of these cases are produced voiceless in the ASD database (see Table 47 for a summary of voicing assimilation in Standard Hungarian and in the speech of the six participants.).

In the samples, it is rare to find voicing assimilation alone. Voicing assimilation frequently combines with other phonological processes, such as complete assimilation (e.g. first entry in Table 42), distortion (e.g. second entry in Table 42) and fronting (e.g. first two entries in Table 43).

Table 42 lists examples of voicing assimilation in coda clusters. Note that apart from voicing assimilation, the first member completely assimilates to the following voiceless alveolar in the first entry. The second entry contains a devoiced, though distorted, fricative.

Table 42: Voicing assimilation in coda clusters

UR[11]	SR[12]	ASR[27]	PhE[13]	Sample[28]	Gloss	PhP[14]	Speaker[29]
zt	z̥t	tː	CCL[17]	*ez+t*	'that' ACC	VA[36]	Bandi
zt	z̥t	ʝ̊t	CCL	*ez+t*	'this' ACC	VA	Feri

Table 43 provides a list of voicing assimilations across morpheme boundary. In the first two entries, the palatals are also fronted, besides being devoiced. The subsequent entries contain complete assimilation, plus fronting of the palato-alveolar fricative in the case of the last entry.

Table 43: Voicing assimilation across morpheme boundary

UR[11]	SR[12]	ASR[27]	PhE[13]	Sample[28]	Gloss	PhP[14]	Speaker[29]
ɟh	ɟ̊h	d̥h	MCL[15]	*hogy+ha*	'in case'	VA[36]	Feri
ɟf	ɟ̊f	d̪̊f	MCL	*nagy+fiú*	'big boy'	VA	Feri

40 voiced obstruent
41 voiceless obstruent

UR[11]	SR[12]	ASR[27]	PhE[13]	Sample[28]	Gloss	PhP[14]	Speaker[29]
zt	z̥t	tː	MCL	*megáz+tat+ok*	'you got wet in the rain'	VA	Misi
gs	g̊ʃ	sː	MCL	*beteg+ség(et)*	'disease'	VA	Misi

The entries in Table 44 are examples of voicing assimilation across word boundary. Since word-final coda devoicing would yield identical forms to the adult ones, it cannot be determined with certainty whether it is a developmental context-sensitive devoicing, true voicing assimilation or mixture of the two. Probably the phenomena should be interpreted as coda-devoicing because the lack of voicing examples in the ASD database (–O[41] +O[40] ↛ +O +O). I include the entries of Table 44 in this section because the possibility of segment interaction in the cluster could not be excluded (cf. Section 3.2).

By and large, the autistic representations are identical to the adult surface representation forms, i.e. the voiced obstruent + voiceless obstruent cluster in the underlying representation surfaces as voiceless + voiceless obstruent cluster (+O[40] –O[41] → –O +O) (cf. Section 5.1).

Additional processes can be found in the last four entries. In the third row, complete assimilation to the alveolar takes place. There is truncation in the sample (indicated in parentheses) in the fourth entry. In the fifth row, the alveolar plosive in the coda is unreleased and the preceding liquid is distorted. In the last row, there is also cluster simplification apart from devoicing (i.e. the bilabial plosive is not realized in the CCC cluster).

Table 44: Voicing assimilation across word boundary

UR[11]	SR[12]	ASR[27]	PhE[13]	Sample[28]	Gloss	PhP[14]	Speaker[29]
zt	z̥t	z̥t	WCL[22]	*ez#Tom+csi*	'this is T.' male name DIM	VA[36]	Ákos
ɟsk	ɟ̊sk	ɟ̊sk	WCL	*egy#skorpió+nak*	'as a scorpion'	VA	Bandi
ɟt	ɟ̊t	tː	WCL	*egy#tükör+ben*	'in a mirror'	VA	Misi
gk	g̊k	g̊k	WCL	*beteg+ség(et)# kap+t+(am)*	'I caught a disease'	VA	Misi

UR[11]	SR[12]	ASR[27]	PhE[13]	Sample[28]	Gloss	PhP[14]	Speaker[29]
ldf	ld̥f	jd̥̚f	WCL	*emel+d#föl*	'lift it up' IMP	VA	Misi
bdk	b̥d̥k	d̥k	WCL	*dobd#ki*	'trash it' IMP	VA	Pisti

Table 45 contains the only example of voicing due to voicing assimilation is observed in Misi's speech. Voicing might also be due to the nasalization of the affricate + plosive cluster (nasalization occurs due to nasal coalescence, covered in 4.4.2.1).

Table 45: Voicing in voicing assimilation (only M)

UR[11]	SR[12]	ASR[27]	PhE[13]	Sample[28]	Gloss	PhP[14]	Speaker[29]
nt͡sb	nt̬͡s̬b	d̃͜z̃[42]b̃	WCL[22]	*Lőrinc#bácsi*	addressing an adult male	VA[36]	Misi

Based on the devoicing examples in this section (Table 42, Table 43 and Table 44), I present a summary of the data in Table 46. The majority of the samples comes from Misi (9 out of 15). His speech contains five voicing assimilation across morpheme and four across word boundary. Bandi exhibits three instances of voicing assimilation, one in coda cluster, one across morpheme and one across word boundary. Pisti, Ákos and Feri each contribute one example to the pool, the former two are found across word boundary, the latter in coda cluster. Zoli exhibited no voicing assimilation.

Table 46: Devoicing in voicing assimilation

Speaker	OCL[38]	CCL[17]	SCL[21]	MCL[15]	WCL[22]
Misi				5	4
Bandi		1		1	1
Pisti					1
Zoli					
Ákos					1
Feri		1			

42 Affrication, voicing and nasalization could not be indicated simultaneously, therefore I use the voiced counterparts of the obstruents.

As a conclusion of this section, I intend to summarize the realization of clusters containing obstruents in Standard Hungarian and in the speech samples of the ASD database with the help of Table 46 and Table 47.

Table 47 shows how clusters are realized in Standard Hungarian and in the ASD database. Shaded cells indicate that there are differences between the two speech patterns. Examples of voicing assimilation are included in the third and the fourth row and are in a bold frame. In the other examples, no phonological process takes place in the adult production, thus, the underlying and the adult surface representations are identical. Note that none of the surface productions contain obstruents with different voicing values (cf. Section 5.1 on voicing assimilation).

In the first scenario, voiceless + voiceless clusters trivially surface unchanged in both speech patterns. In the second row, voiced + voiced clusters do not change in Standard Hungarian, but turn to voiceless-voiceless in examples from the ASD database (also listed in Table 34).

The third and fourth scenarios are examples of the voicing assimilation. In the third scenario, there is an underlying voiceless + voiced cluster. In adult surface representation, it is to be expected that both obstruents are realized as voiced. However, in samples of the ASD database (also included in Table 31, Table 34 and Table 36) the obstruents surface both voiceless. The only counter-example is presented in Table 45. The fourth case includes the opposite order of obstruents, i.e. a voiced + voiceless cluster in the underlying form. Both speech patterns realize that as voiceless + voiceless (as I shown in the tables of this section Table 42, Table 43 and Table 44).

Since in Standard Hungarian sonorants do not participate in assimilation (cf. Section 5.1), it is to be expected that obstruents do not change their voicing value before or after sonorants. On the contrary, in ASD it seems that obstruents get devoiced in every cluster environment. The fifth and sixth cases involve the voiced obstruent the sonorant and vice versa. The adult production does not change the underlying form, but the participants' production contains the obstruents devoiced (cf. entries of Table 30 and Table 31). The last two cases with voiceless obstruents and sonorants surface unchanged in both Standard Hungarian and in the ASD database.

Table 47: Realization of clusters containing obstruents in Standard Hungarian and speech samples of the ASD database. Shaded cells indicate differences in the two productions. Voicing assimilation cases included within a bold frame.

UR[11]	SR[12]	ASR[27]
–O[41]–O	–O–O	–O–O
+O[40]+O	+O+O	–O–O
–O+O	+O +O	–O –O
+O –O	–O –O	–O –O
+O S[43]	+O S	–O S
S +O	S +O	S –O
–O S	–O S	–O S
S –O	S –O	S –O

43 Sonorant

6 Areas of future research

In the future, I plan to investigate the perception of nasals and the voicing values of obstruents, besides production, in order to filter out articulatory limitations. In addition, I would like to record the speech samples in such a way that can be analyzed phonetically. Further, it would also be important to conduct tests measuring the expressive and receptive language skills of the children.

If all of these conditions are given, it would become possible to compare the autistic population to typically developing children and/or other populations exhibiting a phonology disorder.

7 Conclusions

This chapter provides a brief overview of the whole thesis.

In this thesis, my contribution were

(1) an overview of a linguistically relevant findings in the autism literature (Chapter 2)

(2) a database that comprises speech samples from six children on the autistic spectrum (Section 8.1)

(3) a discussion of two prominent phonological processes in autistic speech based on the autism literature and the ASD database (Chapters 4 and 5), which comprises

(a) an introduction of nasal and voicing disturbances,

(b) a comparison of these phonological processes to phonological processes that are typical of adult speech and

(c) analyses of both typical and ASD nasal processes in the Parallel Structures Model.

In Chapter 2, I assess autism as a language disorder. First, various terminological and classificatory issues have been clarified (cf. Section 2.1). In section 2.2, it has been established that surprisingly few ASD studies are conducted on linguistic grounds, in spite of the fact that one of the diagnostic criteria of autism is deviant language.

Some researchers have concluded that autistic language is not markedly different from the typical one, although it may be delayed or, to some extent, it displays similarities with developmental disorders (Tager-Flusberg 1981; Paul 1987; Lord et al 1997; Rapin and Dunn 2003). Following Gathercole and Baddeley (1990), who argued that phonological working memory skills might be the leading cause of phonological disorders, Kjelgaard and Tager-Flusberg (2001) found that the impairment of these skills might result in language impediments in autism as well.

However, a fair number of researchers have asserted that there is a specific language impairment in autism. Until the 90's, studies have been primarily investigated articulation distortion errors in ASD (Bartak et al 1975; Boucher 1976; Bartolucci et al 1976; Bartolucci et al 1977; Tager-Flusberg 1981). Besides articulation, relatively well-researched language impediments in autism included vocalization, prosody and echolalia (e.g. Rutter 1965; Wing 1971; Wing and Ricks 1975; Boucher 1988; Shriberg et al 2001).

As shown, issues specific to phonology have been neglected in ASD studies. By assessing previous research on phonology in autism, I have emphasized that Wolk and Edwards (1993), Wolk and Giesen (2000) and Cleland et al (2010) have already found characteristics attached to phonology in ASD, namely patterns in voicing and nasalization.

In Chapter 3, essential information (i.e. chronological age and general linguistic capabilities) about the participants and about the data collection were presented. Also, the chapter discussed reasons why feature geometries are particularly useful in describing disordered phonologies. The reasons of applying feature geometries were (1) the ability to capture existing combinations of features and excluding the unattested ones, (2) the introduction of an empirically motivated internal structure within segments and thus (3) accommodating segment alternations and interactions. The feature geometry of PSM I have chosen to apply is a radically economical approach. The PSM is able to capture segment interactions via internal hierarchical representation of segments and permitting re-association of features. Processes involving nasals are represented by using the PSM (in Chapter 4).

This work describes features characteristic of the autistic subjects. Two of these features are, by demonstration of Chapter 4 and 5, nasal and voicing disturbances. Additional potential characteristics are briefly mentioned in Chapter 6.

The two goals of this thesis were to describe inter and intra-speaker prevalence rates of voicing and nasal disturbances in the speech of participants. Chapter 4 first introduced the two phonological processes related to nasals (i.e. nasal place assimilation and nasal coalescence) in Standard Hungarian. Nasal disturbances in the ASD database show that the production of singleton nasals is severely limited in every phonotactic position in every participant's speech (cf. findings of 4.4.1). Second, the production of nasals in clusters was also found atypical. Considering vowel-nasal-consonant sequences, nasal coalescence is found to be the most frequent phenomenon. As detailed in Table 22, five out of six informants demonstrate nasal coalescence when realizing nasal-consonant clusters, three of them unanimously and two with a relatively high occurrence rate (57% and 80%).

Chapter 5 discussed voicing disturbances. Concerning voicing disturbances, devoicing and voicing assimilation have proved to be the most prominent phonological processes in the ASD database. Six out of six informants exhibit non-developmental devoicing patterns in clusters, without an exception (cf. Table 37). The essential difference between the adult pronunciation and the speech samples is that every obstruent that is in a cluster is realized as devoiced, regardless of position and neighboring segments. As mentioned, voicing is not a prominent phonological process in neither of the speakers' speech samples and in neither phonotactic positions (summarized in Table 41).

Voicing assimilation in Hungarian is discussed and compared to the production of the participants. Voicing assimilation that would result in regressive voicing of the first member has not been attested in the database (see comparison of ASD and standard productions in Table 47). Instead of the voicing of the first member in the expected contexts, devoicing of the second member is observed. As a consequence, voiced non-nasalized obstruents are only to be found as singletons in the informants' samples. As for devoicing due to voicing assimilation, five out of six speakers exhibit the process and all of these five exhibits this without an exception (summarized in Table 37).

All in all, the two phonological features that has been investigated in the thesis are proved to be prevalent both from an intra-speaker and an inter-speaker perspective. Finally, more research is needed to confirm these findings along the lines presented in Chapter 6.

8 Appendix

8.1 Transcription of speech samples

Table 48: Speech samples sorted by (1) phonological process (2) phonotactic environment (3) speaker

UR[11]	SR[12]	ASR[27]	PhE[13]	Sample[28]	Gloss	PhP[14]	Speaker[29]
nt		ɲc	SCL[21]	*csont+ok*	'bone' PL	BAC[34]	Bandi
tːv		kː	WCL[22]	*ott#van*	'there it is'	BAC	Zoli
z		c	WFC[20]	*ez#val+ó*	’this fits’	BAC	Misi
ɟd		gː	WFC	*hagy+d*	'leave it' IMP	BAC	Zoli
n-p-p		t-t-t	WMO[19]	*na(gy)+papa*	’grandpa’	BAC	Ákos
				od(a#al)á	’there to under something’	BLE[44]	Ákos
				kérde(z+(és#lehet)ő+ség+ét	'the opportunity to ask'	BLE	Feri
				má(sik+at#ad+d#)ide	'give the other to me'	BLE	Zoli
ɒ-ɒ-eː		o-o-eː	NUC	*Kata#né(ni)*	addressing an adult female	CEN	Ákos
ɒ-ɒ-ɒ		o-o-o	NUC	*na(gy)+papa*	’grandpa’	CEN	Ákos
ɒ-ɒ		ɒ-o	NUC	*az#anya*	’the mother’	CEN	Ákos
ɒ-ɒ		o-o	NUC[45]	*papa*	’grandpa’	CEN[46]	Ákos
ɒ		o	NUC	*az+t*	'that' ACC	CEN	Pisti
ɛ-ɒ-o		ɛ-o-o	NUC	*nem#ad+om*	'I don't give it (to you)'	CEN	Zoli
ɒ-io		o-io	NUC	*kamion*	'lorry'	CEN	Zoli
ɒ-ɒ-ɒ		ɒ-o	NUC	*hagy+d#ab+ba*	'FORp it' IMP	CEN	Zoli
ɒ-ɒ		o-o	NUC	*rajta*	'on that'	CEN	Zoli
ɒ		o	NUC	*szia*	inf. greeting	CEN	Zoli
aː		ɒː	NUC	*ház+ikó*	house DIM	CEN	Zoli
omb		õːb̃	CCL	*gomb*	’button’	COA[24]	Misi

44 Blending (underlying and surface representation forms are not transcribed)
45 Nucleus
46 Centralizing

UR[11]	SR[12]	ASR[27]	PhE[13]	Sample[28]	Gloss	PhP[14]	Speaker[29]
omb		o͠ːb̃˺	CCL	*gomb*	’button’	COA	Misi
lj	jː	lʲ	CCL[17]	*figyel+j*	'listen' IMP	COA	Misi
int͡ʃ	in̄t͡ʃ	i͠ːt͡s	CCL	*nincs*	'none'	COA	Pisti
nk	ŋk	k̃ː	CCL	*tapsol+u(nk)*	'we clap'	COA	Pisti
pn		p̃ː	MCL	*kap+ni*	'to get'	COA	Bandi
øɲvj		ø͠ːb̃ː	MCL	*könyv+jelző*	'book-marker'	COA	Bandi
gn		g̃ː	MCL[15]	*meg+néz+het +jük*	'we can have a look at it'	COA	Bandi
ʃtr		ʃ→	MCL	*test+rész*	'body part'	COA	Feri
nv	ɱv	mː	MCL	*kölcsön+vehe t+em*	'can I borrow'	COA	Feri
lj	jː	lʲ	MCL	*talál+ja*	'find (out)' IMP	COA	Feri
eːɲk	eː ɲ͡ŋk	e͠ːk̃	MCL	*le+fény+kép +ez*	’(s)he makes a photo’	COA	Misi
oɲf		o͠ːf̃	MCL	*karácsony+f á+ra*	’onto the Christmas tree’	COA	Misi
lj	jː	lʲ	MCL	*meg+vigasz +tal+ja*	's/he comforts him/her'	COA	Misi
lj	jː	lʲ	MCL	*csinál+ja*	'do' 1/3 TR	COA	Misi
zt	z̥t	ʃ	NUC	*az+t*	'that' ACC	COA	Pisti
pr		t	OCL[38]	*próbál+d*	'try' IMP	COA	Bandi
ɛng	ɛŋg	ɛ͠ːg̃	SCL	*tenger+be*	'in the sea'	COA	Bandi
ong	oŋg	o͠ːg̃	SCL	*korong+om*	'my disc'	COA	Feri
dv		d̃	SCL	*udvarra*	'to the yard'	COA	Feri
int		i͠ːt̃	SCL	*palacsinta*	’pancake’	COA	Misi
ong	oŋg	o͠ːg̃	SCL	*zongorá+(d)*	'your piano'	COA	Misi
ɒng	ɒŋg	ɒ͠ːg̃	SCL	*hang+os+an*	’loudly’	COA	Misi
omp		o͠ːp̃	SCL	*sorompó*	’pike, barrier’	COA	Misi
ɒng	ɒŋg	ɒ͠ːg̃	SCL	*hang+ja*	’his/her voice’	COA	Misi
ps-nk	ps-ŋk	k̃ː	SCL	*tapsol+u(nk)*	'we clap'	COA	Pisti
indj	iɲɟ	i͠ːɟ̃	SCL	*mindjárt*	'soon'	COA	Pisti
und		u͠ːd̃	SCL	*Grundi(g)*	brand name	COA	Pisti

UR[11]	SR[12]	ASR[27]	PhE[13]	Sample[28]	Gloss	PhP[14]	Speaker[29]
tr		kː	SCL	*metró*	'underground'	COA	Zoli
int͡ʃt	in̄t͡ʃ	ĩ͡ːt̃	WCL	*nincs#több*	'no more'	COA	Feri
tj		cː	WCL	*kicsit#játsz+ hat+sz*	'play a bit'	COA	Misi
ɒnh	ɒŋh	ɒ̃͡ːh̃	WCL	*olyan#hang+ ja*	'his/her voice (is) such'	COA	Misi
nb	mb	b̃	WCL	*tükör+ben#B alázs*	'Balázs (male name) in the mirror'	COA	Misi
ɒnb		ɒ̃͡ːb̃	WCL	*van#benn+e*	'(sth) IS inside'	COA	Misi
omv	oɱv	õ͡ːṽ	WCL	*ad+om#vissz a*	'I give it back'	COA	Misi
ɛmb		ɛ̃͡ːb̃	WCL	*nem# beszél+get+e k*	'I am not talking'	COA	Misi
tːv	tːv/tv	pː	WCL	*ott#van*	'there it is'	COA	Zoli
tːv	tːv/tv	kː	WCL	*ott#van*	'there it is'	COA	Zoli
mt		p̃	WCL	*nem#tudom*	'I don't know'	COA	Zoli
ɛnd		ɛ̃͡ːb̃	WFC	*rend+ben*	'alright'	COA	Feri
int͡s	in̄t͡s	ĩ͡ːt͜s	WFC	*Lőrinc*	male name	COA	Zoli
v-g		b-b	WIO[47]	*vége*	'finish' n.	COA	Ákos
m-k		b̃-k̬̃	WIO	*mi+k*	'what' pl.	COA	Bandi
t͡ʃ-z		s-z̥	WIO	*csúz+dáz+ta m*	'I played on the slide'	COA	Feri
t͡ʃ-z		s-z̥	WIO	*csúz+dáz+ta m*	'I played on the slide'	COA	Feri
ɟ-n		d̃-n	WMO	*Bugyi+n*	'in B.' (village name)	COA	Bandi
d-n-v-r		d-n-d̃-r	WMO	*denevér*	'bat'	COA	Feri
pj		p͡j	MCL	*meg+harap+ ja*	'it bites it'	COA	Misi
ɟj	ɟː	dʲ	MCL	*hagy+ja+(d)*	'leave it' IMP	COA	Zoli
ms		t͡sʃ	CCL	*ne(m)#szeret +ed*	'you don't like it'	DEL[48]	Misi
ɟsk	ɟ̊sk	ɟ̊sk	ɟ̊s	*egy#s(k)orpió +nak*	'as a scorpion'	DEL	Bandi

47 Word-initial onset

48 Deletion (underlying and surface representation forms are not transcribed)

UR[11]	SR[12]	ASR[27]	PhE[13]	Sample[28]	Gloss	PhP[14]	Speaker[29]
t͡sh	t͡sh	t͡s	MCL	*játsz+ (h)at+ok*	’I can play’	DEL	Misi
ʃh		s	MCL	*vitorlá+s+ (h)ajó*	’sailing boat’	DEL	Misi
rh	rh	jː	MCL	*kér+(h)et+ek*	’I can ask’	DEL	Misi
gh	g̊h	g̊	MCL	*meg+ (h)arap+ja*	’(it) bites it’	DEL	Misi
ɒ-ɒ-ɒ		ɒ-o	NUC	*hagy+d ab+ (ba)*	'stop it' IMP	DEL	Zoli
dst	d̥st	ʃt	SCL	*ró(d)sztá(r)*	'roadstar' brand name	DEL	Pisti
kdm	k̬dm	km	WCL	*rak(d)#már*	'put, please'	DEL	Bandi
gh	g̊h	g̊	WCL	*egy#még#*(h)*iány+z+ik*	’one is still missing’	DEL	Misi
			WCL	*e(z)#motor*	’this motorbike’	DEL	Misi
			WFC	*tessé(k)*	'please'	DEL	Ákos
			WFC	*volt+á(l)*	'you were'	DEL	Ákos
			WFC	*ügye(s)*	’skilful’	DEL	Ákos
			WFC	*rá+csapo(k)*	’I hit on it’	DEL	Ákos
			WFC	*a(z)+za(l)*	’with that’	DEL	Ákos
			WFC	*hol#va(n)*	'where is it'	DEL	Feri
			WFC	*kuty+u(s)# meg+vigasz +tal+ja*	’the doggie comforts him/her’	DEL	Misi
			WFC	*ah+ho(z)*	’to that’	DEL	Misi
			WFC	*oda+rak+o(m)*	’I put it there’	DEL	Misi
			WFC	*szék+e(n)*	'on the chair'	DEL	Pisti
			WFC	*Grundi(g)*	brand name	DEL	Pisti
			WFC	*ródsztá(r)*	'roadstar' brand name	DEL	Pisti
ɟd		dː	WFC	*ha(gy)+d*	'leave it' IMP	DEL	Zoli
			WFC	*viszlá(t)*	inf. farewell	DEL	Zoli
			WFC	*ő#mi+(t)# szeret+ne*	'what he wants'	DEL	Zoli
			WFC	*ügye(s)#volt*	'(this) was skilful'	DEL	Zoli

UR[11]	SR[12]	ASR[27]	PhE[13]	Sample[28]	Gloss	PhP[14]	Speaker[29]
			WFC	*o(tt)*	'there'	DEL	Zoli
			WFC	*tű(z)*	'fire'	DEL	Zoli
			WFC	*gyógyít+ás+sa(l)*	'with cure'	DEL	Zoli
			WFC	*a(z) a(z)*	'that is the ()'	DEL	Zoli
			WFC	*kér+e(d)*	'you ask for it'	DEL	Zoli
			WFC	*hagy+ja+(d)#békén*	'leave it alone' IMP	DEL	Zoli
			WFC	*bocsána(t)*	'sorry'	DEL	Zoli
			WIO	*(h)ol#va(n)*	'where is it'	DEL	Feri
			WIO	*(h)ova*	'where'	DEL	Pisti
ɲ		-	WMO	*verse(ny)+autó*	'racing car'	DEL	Bandi
zt	z̥t	ʝ̊t	MCL	*ez+t*	'this' ACC	DIS[49]	Feri
rː		rj	MCL	*ar+ra*	'that way'	DIS	Pisti
zt	z̥t	ʃ	NUC	*az+t*	'that' ACC	DIS	Pisti
ʃt		ʃ͢ t	SCL	*test+es*	'body' ADJ	DIS	Feri
ʃ		ʃ͢s̠	WFC	*és*	'and'	DIS	Bandi
z		f	WFC	*ez#itt*	'this here'	DIS	Feri
ʃ		s̠͡ʃ͢	WFC	*is*	'too'	DIS	Feri
n		m	WFC	*oldal+on*	'on (the) side'	DIS	Feri
t͡ʃ-z		ɵ-z̥	WIO	*a#csúz+da*	'the slide'	DIS	Feri
ɒr		aː	WMC	*markoló+t*	'crane' ACC	DIS	Pisti
r		j	WMO	*kér+ek*	'I ask'	DIS	Bandi
lː		rː	WMO	*sellő*	'mermaid'	DIS	Bandi
z		ʝ	WMO	*igazi*	'real'	DIS	Feri
l		r	WMO	*oldal+on*	'on (the) side'	DIS	Feri
l		r	WMO	*oldal+on*	'on (the) side'	DIS	Feri
s		s̠ʃ͢	WMO	*köszönöm*	'thank you'	DIS	Zoli
j		l	WMO	*hajó+t*	'ship' ACC	DIS	Zoli
m		b	WFC	*állatom*	'my animal'	DN[31]	Bandi
ɲ		j	WIO	*nyer+tek*	'they won'	DN	Bandi

49 Distortion

UR[11]	SR[12]	ASR[27]	PhE[13]	Sample[28]	Gloss	PhP[14]	Speaker[29]
m		b	WIO	*mi*	'what'	DN	Bandi
m		b	WIO	*meleg*	'warm'	DN	Bandi
n		d	WIO	*nem#tud+ott*	's/he couldn't'	DN	Pisti
m		b	WIO	*mindjárt*	'soon'	DN	Pisti
m		b	WIO	*mi*	'what'	DN	Pisti
nd		nd̥	CCL	*Botond*	male name	DV[35]	Feri
sb	s̬b	sb̥	MCL	*kis+baba*	'small baby'	DV	Bandi
dn	d̚n	t:	MCL	*tud+nád*	'you could'	DV	Feri
ɟm		ɟ̊m	MCL	*egy+más*	'other'	DV	Feri
kb	k̬b	kb̥	MCL	*mesé+k+be*	'in the tales'	DV	Feri
ksb	k̬s̬b	kb̥	MCL	*Minimax+ba*	'on M.' (cartoon channel)	DV	Feri
lz		lz̥	MCL	*könyv+jel+ző +jük*	'their bookmarker' POSS	DV	Feri
mb		mb̥	MCL	*könyv+em+b e*	'book' LOC POSS	DV	Feri
ɲvr		v̥͠r	MCL	*könyv+re*	'on (the) book'	DV	Feri
rb		rb̥	MCL	*nyár+ba*	'in (the) summer'	DV	Feri
zː		z̥ː	MCL	*kérd+ez+zek*	'(what) I ask' IND	DV	Feri
zd		z̥d̥	MCL	*csúz+dáz+ta m*	'I played on the slide'	DV	Feri
zd		z̥d̥	MCL	*csúz+da*	'slide'	DV	Feri
gh	g̊h	g̊	MCL	*meg+harap+ ja*	'(it) bites it'	DV	Misi
zt	z̥t	tː	MCL	*megáz+tat+ ok*	'you got wet'	DV	Misi
ɲv		ɱv̥	SCL	*könyv+em+b e*	'book' LOC POSS	DV	Feri
dm		d̥m	WCL	*szabad#mege n+ni*	'allowed to eat'	DV	Feri
zv		cf	WCL	*ez#val+ó*	'this fits'	DV	Misi
dn		d̥n	WCL	*elő+vesz+ed #nek+em*	'you take it out for me'	DV	Misi

UR[11]	SR[12]	ASR[27]	PhE[13]	Sample[28]	Gloss	PhP[14]	Speaker[29]
ɟm		ɟ̊m	WCL	*egy#még*	’one still’	DV	Misi
kb	g̊b	kb̥	WCL	*rak+juk#be*	’let’s put it inside’	DV	Misi
ʃv		sv̥	WCL	*ügyes#vol+t*	’that was clever/skilful’	DV	Misi
zl		z̥l	WCL	*ez#le+es+ett*	’this has fallen down’	DV	Misi
zm		z̥m	WCL	*ez#motor*	’this bike’	DV	Misi
ɟb		ɟ̊b̥	WCL	*egy#beteg+s ég+et*	’a disease’ ACC	DV	Misi
ɟb		ɟ̊b̥	WCL	*egy#beteg+s ég+et*	'a disease’ ACC	DV	Misi
zv		ɟ̊v̥	WCL	*ez#val+ó*	’this fits’	DV	Misi
z		z̥	WFC	*doboz*	'box'	DV	Ákos
d		d̥	WFC	*tudod*	'you can'	DV	Feri
ɟ		ɟ̊	WFC	*vagy*	'(you) are'	DV	Feri
z		f	WFC	*ez#itt*	'this here'	DV	Feri
z		z̥	WFC	*doboz*	'box'	DV	Feri
d		d̥	WFC	*tud+nád*	'you could'	DV	Feri
d		d̥	WFC	*el+kap+od#*	’you catch it’	DV	Misi
g		g̊	WFC	*ég#a#gyertya #ég*	’the candle is burning burning’ (nursery rhyme)	DV	Misi
g		g̊	WFC	*ég*	'burn' V	DV	Misi
dː		d̥ː	WFC	*ad+d*	'give' IMP	DV	Pisti
z		z̥	WFC	*ez*	'this'	DV	Zoli
zz	zː	z̥	WFC	*vigyáz+z*	'beware'	DV	Zoli
b		b̥	WIO	*Barnus*	male name	DV	Feri
b		b̥	WIO	*Botond*	male name	DV	Feri
d		d̥	WIO	*de*	'yet'	DV	Feri
d		d̥	WIO	*doboz*	'box'	DV	Feri
g		g̊	WIO	*Gergő*	male name	DV	Feri
z		z̥	WIO	*zöld*	'green'	DV	Feri

UR[11]	SR[12]	ASR[27]	PhE[13]	Sample[28]	Gloss	PhP[14]	Speaker[29]
b		b̥	WMO	*doboz*	'box'	DV	Feri
d		d̥	WMO	*madar+ak*	'bird' PL	DV	Feri
g		g̊	WMO	*Gergő*	male name	DV	Feri
ɟ		ɟ̊	WMO	*nagyon*	'very'	DV	Feri
zt	z̥t	tː	MCL	*az+t*	'that' ACC	FOR[50]	Pisti
z		c	WFC	*ez#val+ó*	'this fits'	FOR	Misi
v-g		b-b	WIO	*vége*	'finish' n.	FOR	Ákos
t-s		t-t	WIO	*te#szere(t+né l)*	'you would like'	FOR	Ákos
s		t͡s	WIO	*szia*	inf. greeting	FOR	Ákos
h		p	WIO	*húsz*	'twenty'	FOR	Bandi
v		b	WIO	*valami*	'something'	FOR	Feri
f		p͡f	WIO	*fa*	'wooden'	FOR	Feri
s		t͡s	WIO	*szét+es+ett*	'it has fallen apart'	FOR	Misi
s		t	WIO	*szomorú*	'sad'	FOR	Misi
s		t͡s	WIO	*szia*	'greeting' INF	FOR	Misi
ms		t͡sʃ͢	WIO	*nem#szeret+ ed*	'you don't like it'	FOR	Misi
f		p͡f	WIO	*fa*	'tree'	FOR	Misi
t͡ʃ		t	WIO	*csillag+ot*	'star' ACC	FOR	Misi
v		b	WIO	*vezet+ő*	'driver'	FOR	Pisti
s		t	WIO	*szék+e(n)*	'on the chair'	FOR	Pisti
v		b	WIO	*vigyáz+z*	'beware'	FOR	Zoli
s		t͡s	WIO	*szia*	inf. greeting	FOR	Zoli
s		t͡c	WMC	*viszlá(t)*	inf. farewell	FOR	Zoli
t͡ʃ		t	WMO	*(Lőrinc) bácsi*	addressing an adult male	FOR	Ákos
f		p	WMO	*elefá(nt+os)*	'elephant'+ adj. marker	FOR	Ákos
v-b		b-b	WMO	*oviba*	'kindergarten' LOC	FOR	Feri

50 Fortition

UR[11]	SR[12]	ASR[27]	PhE[13]	Sample[28]	Gloss	PhP[14]	Speaker[29]
t͡ʃ		t	WMO	*mi+csoda*	'what'	FOR	Feri
sː		tː	WMO	*le+vesz+szük*	'we take (it) down'	FOR	Pisti
t͡ʃ		t	WMO	*bocsána(t)*	'sorry'	FOR	Zoli
ɟh	ɟ̊h	d̥h	MCL	*hogy+ha*	'in case'	FRO[51]	Feri
ɟf	ɟ̊f	d̪̊f	MCL	*nagy+fiú*	'big boy'	FRO	Feri
ʃh		s	MCL	*vitorlá+s+ha jó*	'sailing boat'	FRO	Misi
gʃ		sː	MCL	*beteg+ség(et)*	'disease'	FRO	Misi
ɟj	ɟː	dʲ	MCL	*hagy+ja+(d)*	'leave it' IMP	FRO	Zoli
o		i	NUC	*vacsorá+n*	'at dinner'	FRO	Feri
eː	eː	iː	NUC	*béké+n*	'alone' lit. 'in peace'	FRO	Zoli
ʃː		s	SCL	*tessé(k)*	'please'	FRO	Ákos
t͡ʃk		t͡sk	SCL	*macska*	'cat'	FRO	Bandi
pt͡ʃ		t͡sː	SCL	*be+kapcs+ol +hat+om*	'I can turn it on'	FRO	Misi
t t͡ʃ	t͡ʃː	t͡s	WCL	mi+t#csinál	'what is it doing'	FRO	Misi
ʃ		s	WCL	*ügyes#vol+t*	'that was skilful'	FRO	Misi
ɲ		n	WFC	*bizony*	'sure'	FRO	Pisti
k-t		t-t	WIO	*Kata#né(ni)*	addressing an adult female	FRO	Ákos
t͡ʃ		t͡s	WIO	*csak*	'only, yet'	FRO	Bandi
h		p	WIO	*húsz*	'twenty'	FRO	Bandi
t͡ʃ		t͡s	WIO	*csinál+ni*	'to do'	FRO	Feri
t͡ʃ		t͡s	WIO	*csak*	'only'	FRO	Feri
t͡ʃ		t͡s	WIO	*csillag+ot*	'star' ACC	FRO	Misi
t͡ʃ		t͡s	WIO	*csoki+t*	'chocolate' trunc. ACC	FRO	Misi
ɟ		d	WIO	*ügye(s)*	'skilful'	FRO	Zoli
ɟ		d	WMO	*ügye(s)*	'skilful'	FRO	Ákos
ɟ		d	WMO	*Bugyi+n*	'in B.' (village	FRO	Bandi

51 Fronting

UR[11]	SR[12]	ASR[27]	PhE[13]	Sample[28]	Gloss	PhP[14]	Speaker[29]
					name)		
t͡ʃ		t͡s	WMO	*vacsorá+n*	'at dinner'	FRO	Feri
t͡ʃ		t͡s	WMO	*macska*	'cat'	FRO	Feri
n		m	WMO	*ugyan+ilyen*	'same kind'	FRO	Feri
c		tʲ	WMO	*kutya*	'dog'	FRO	Feri
t͡ʃ		t͡s	WMO	*becsukj(a)*	's/he closes it'	FRO	Pisti
k		t	WMO	*szék+e(n)*	'on the chair'	FRO	Pisti
c		t	WMO	*kutyus*	'dog' DIM	FRO	Pisti
k		t	WMO	*oké*	'OK'	FRO	Zoli
cʃ		t͡s	WMO	*kicsi+t*	’small’ ACC	FRO	Misi
u-o		u-u	NUC	*bele+ugr+ok*	'I jump in'	HEI[52]	Bandi
eː		iː	NUC	*méter+ű (AS: méter+es)*	'meter' adj.	HEI	Bandi
eː		i	NUC	*foly+ékony*	'liquid' ADJ	HEI	Feri
eː		iː	NUC	*én*	'I'	HEI	Feri
o-o-uː		u-u-uː	NUC	*szomorú*	'sad'	HEI	Misi
eː		iː	NUC	*szét+es+ett*	’it has fallen apart’	HEI	Misi
oː		u	NUC	*való*	'is'	HEI	Pisti
oː		u	NUC	*ródsztá(r)*	'roadstar' brand name	HEI	Pisti
oː		uː	NUC	*gyógyít+ás+sal*	'with cure'	HEI	Zoli
ɒ-o-ɒ		ɒ-u-ɒ	NUC	*add#oda*	'give that'	HEI	Zoli
				olya[ma]t	'that kind' ACC	INS[53]	Feri
ɒutoːt		oːtoːtoː	NUC	*autót[ó]*	'car' ACC	INS	Zoli
			NUC	*doktor[ó]*	'doctor'	INS	Zoli
eɒ		ejɒ	WIO	*ide#[j]a*	'here on the (sofa)'	INS	Zoli
sɒk		skɒk	WMO	*mos+ak+od+ik*	’(s)he is washing him/herself’	INS	Misi

52 Heightening
53 Insertion

UR[11]	SR[12]	ASR[27]	PhE[13]	Sample[28]	Gloss	PhP[14]	Speaker[29]
kør		kjøj	WMO	*tükör+ben*	'in (a) mirror'	INS	Misi
n-zt	n-z̥t	n-z̥͡t	MCL	*meg+néz+te*	's/he watched it'	LDA[54]	Bandi
dv-nt͡s-m		mː-t̃͡s̮-m	MCL	*kedvenc+em*	'favourite' POSS	LDA	Feri
lː-r		rː-r	WFC	*kell#kérni*	'have to ask'	LDA	Feri
k-s		s-s	WIO	*kész*	'ready'	LDA	Ákos
n-p-p		t-t-t	WIO	*na(gy)+papa*	'grandpa'	LDA	Ákos
m-k		b̆-k̬̆	WIO	*mi+k*	'what' pl.	LDA	Bandi
v-t		t-t	WIO	*vonat+os*	'train' ADJ	LDA	Feri
r-s		r-r	WIO	*szeret+nél#sellő*	'would you (like to be a) mermaid'	LDA	Feri
r-l		r-r	WIO	*szeret+nél#sellő#lenni*	'would you like to be a mermaid'	LDA	Feri
l-tr		r-tr	WIO	*létra*	'ladder'	LDA	Feri
l-b		b-b	WIO	*Lőri(nc)#bá(csi)+nak*	'to L. B.' an adult male	LDA	Pisti
l-r		j-j	WIO	*Lőrinc#bácsi*	addressing a male adult	LDA	Zoli
t-m		t̆-m	WMC	*örül+t+em*	'I was glad'	LDA	Bandi
s-ø	s-j	t͡s-t͡s	WMO	*szi+ja*	inf. greeting	LDA	Ákos
k-f	k-f	k-k	WMO	*ki+fog+ták*	'they have caught it'	LDA	Bandi
g-n		g̃	WMO	*igen*	'yes'	LDA	Bandi
t͡ʃ-z		ɵ-z̥	WMO	*csúz+da*	'slide'	LDA	Feri
v-m		m-m	WMO	*nev+em+et*	'my name' ACC	LDA	Feri
v-b		b-b	WMO	*oviba*	'kindergarten' LOC	LDA	Feri
r-ln		n-n	WMO	*le+merül+ni*	'to dive'	LDA	Feri
r-lː		r-rː	WMO	*szeret+nél#sellő*	'would you (like to be a) mermaid'	LDA	Feri
m-v		m-m	WMO	*szem+üveg+em+be*	'with my glasses'	LDA	Feri

54 Long distance assimilation

UR[11]	SR[12]	ASR[27]	PhE[13]	Sample[28]	Gloss	PhP[14]	Speaker[29]
m-t-t-m		t-t-t-m	WMO	*meg+mutat+ om*	'I show it'	LDA	Feri
m-b		m-m	WMO	*Moby*	name (Moby Dick)	LDA	Feri
d-n-v-r		d-n-ð̃-r	WMO	*denevér*	'bat'	LDA	Feri
v-d		d-d	WMO	*olvas+d#el*	'read it' IMP	LDA	Pisti
v-d		d-d	WMO	*olvas+d#el*	'read it' IMP	LDA	Pisti
r-b		b-b	WMO	*Lőri(nc)#bá(csi)+nak*	'to L. B.' an adult male	LDA	Pisti
m-d		m-m	WMO	*mi+csoda*	'what'	LDA	Pisti
ɟ-r		ɟ-ɟ	WMO	*gyere*	'come (here)' IMP	LDA	Pisti
mt-d		p̃-p	WMO	*nem#tudom*	'I don't know'	LDA	Zoli
l-r		l-l	WMO	*Lőrinc*	male name	LDA	Zoli
m		mː	WFC	*nem#ad+om*	'I don't give it (to you)'	LEN[30]	Zoli
ɲ		ɲː	WMO	*eny+ém*	'mine'	LEN	Zoli
n		nː	WMO	*néni*	addressing a female adult	LEN	Zoli
rl-r		rː-l	WCL	*fehér#ló+ra*	'on (a) white horse'	MET[55]	Feri
n-v		v-n	WIO	*narvál*	'narwhal'	MET	Bandi
m-n		n-m	WIO	*minimaxba*	'on M.' (cartoon channel)	MET	Feri
gj		jː	MCL	*ki+farag+ják*	'they carve it'	MOA[56]	Feri
o-ɒ-ɛ-ɛ-ɛ		o-ɒ-ø-ø-ø	NUC	*ott#a#tete+je*	'there is the top of it'	MOA	Ákos
ɛ-eː		ɛ-ɛ	NUC	*tessé(k)*	'please'	MOA	Ákos
eː-i		iː-i	NUC	*néni*	addressing a female adult	MOA	Zoli
pt͡ʃ		t͡sː	SCL	*be+kapcs+ol +hat+om*	'I can turn it on'	MOA	Misi
g		j	SCL	*igen*	'yes'	MOA	Misi
ʃd	ʃ̬d	dː	SCL	*olvas+d*	'read' IMP DET	MOA	Pisti

55 Metathesis
56 Manner of assimilation

UR[11]	SR[12]	ASR[27]	PhE[13]	Sample[28]	Gloss	PhP[14]	Speaker[29]
tr		tː	SCL	*metró*	underground	MOA	Zoli
rl		rː	WCL	*fehér#ló+ra*	'on (a) white horse'	MOA	Feri
tm	tm/ t̚m	mː	WCL	hát#meg+harap+ja	'well, it bites it'	MOA	Misi
mt		tː	WCL	*nem#tud+ott*	's/he couldn't'	MOA	Pisti
mv-n	ɱv-n	mː-m	WFC	*neke+m#van*	'I have'	MOA	Feri
mt		tː	WFC	*nem#tud+ott*	's/he couldn't'	MOA	Pisti
l-r		r-r	WIO	*Lőrinc*	male name	MOA	Feri
nj	ɲː	nː	WIO	*men+jek*	'should I go'	MOA	Pisti
v		n	WMO	*felolvasod*	'you read it out'	NAS[57]	Feri
l		l̃	WMO	*felolvasod*	'you read it out'	NAS	Feri
l		l̃	WMO	*vala+ki*	'someone'	NAS	Feri
l		l̃	WMO	*talál+ja*	'find (out)' IMP	NAS	Feri
mt͡ʃ		nt͡ʃ	MCL	*Tom+csi*	T. male name DIM	POA[16]	Ákos
gt	g̊t	tː	MCL	*ki+fog+ták*	'they have caught it'	POA	Bandi
tk		tː	MCL	*követ+kez+ik*	'next' v.	POA	Feri
gj		jː	MCL	*ki+farag+ják*	'they carve it'	POA	Feri
dv-nt͡s-m		mː-t͜s̃-m	MCL	*kedvenc+em*	'favourite' POSS	POA	Feri
zt	z̥t	tː	MCL	megáz+tat+ok	'you got wet'	POA	Misi
tk		kː	MCL	követ+kez+ik	'it is next' v.	POA	Misi
pt		tː	MCL	*kap+t+(am)*	'I caught'	POA	Misi
kt		tː	MCL	*szok+tál*	'you habitually do (sth)'	POA	Misi
gl		dl	MCL	*meg+lep+et +és*	'surprise'	POA	Misi
gh	g̊h	kː	MCL	*meg+harap+ja*	'it bites him/her'	POA	Misi
pt͡ʃ		t͡ʃː	MCL	*rep+csi*	'airplane'	POA	Zoli

57 Nasalization

UR[11]	SR[12]	ASR[27]	PhE[13]	Sample[28]	Gloss	PhP[14]	Speaker[29]
					DIM		
pt͡ʃ		t͡ʃː	MCL	*rep+csi*	'airplane' DIM	POA	Zoli
ɛ-eː		ɛ-ɛ	NUC	*tessé(k)*	’please’	POA	Ákos
o-ɒ		ɒ-ɒ	NUC	*oda*	'there'	POA	Pisti
ɒu-oː		ɒː-uː	NUC	*autó+t*	'car' ACC	POA	Pisti
t-m		t-n	SCL	*hatalmas*	'enormous'	POA	Feri
lv-ʃn		n-ʃn	SCL	*olvas+ni*	'to read'	POA	Feri
kt		tː	SCL	*október+be*	'in October'	POA	Feri
ʃt		tː	SCL	e*ste*	’evening’	POA	Misi
pt͡ʃ		t͡sː	SCL	*be+kapcs+ol +hat+om*	’I can turn it on’	POA	Misi
g		j	SCL	*igen*	'yes'	POA	Misi
g		d	SCL	*igen*	'yes'	POA	Misi
ʒg		gː	SCL	*meg+vizsgál +ni*	'to examine'	POA	Pisti
ʒg		gː	SCL	*meg+vizsgál +ni*	'to examine'	POA	Pisti
sd	s̬d	dː	SCL	*olvas+d#el*	'read it' IMP	POA	Pisti
kt		tː	SCL	*doktor*	'doctor'	POA	Pisti
kt		tː	SCL	*doktor[ó]*	'doctor'	POA	Zoli
nm		mː	WCL	*én#meg+mon d+om*	'I tell it'	POA	Feri
ɟt	ɟ̊t	tː	WCL	*egy#tükör+b en*	'in a mirror'	POA	Misi
mv-n		mː-m	WFC	*neke+m#van*	'I have'	POA	Feri
b-n		b-b̃	WFC	*rend+ben*	'alright'	POA	Feri
k-s		s-s	WIO	*kész*	’ready’	POA	Ákos
b-t͡ʃ		t-t	WIO	*(Lőrinc) bácsi*	addressing an adult male	POA	Ákos
d-f		b-f	WIO	*delfin*	'dolphin'	POA	Bandi
v-t		t-t	WIO	*vonat+os*	'train' ADJ	POA	Feri
nj	ɲː	nː	WIO	*men+jek*	'should I go'	POA	Pisti
l-b		b-b	WIO	*Lőri(nc)#bá(csi)+nak*	'to L. B.' an adult male	POA	Pisti

UR[11]	SR[12]	ASR[27]	PhE[13]	Sample[28]	Gloss	PhP[14]	Speaker[29]
l-r		j-j	WIO	*Lőrinc#bácsi*	addressing a male adult	POA	Zoli
s-ø	s-j	t͡s-t͡s	WMO	*szi+ja*	inf. greeting	POA	Ákos
d-b-z		d-d-s	WMO	*doboz*	'box'	POA	Ákos
n-m		m-m	WMO	*köszönöm*	'thank you'	POA	Bandi
k-f	k-f	k-k	WMO	*ki+fog+ták*	'they have caught it'	POA	Bandi
ɟ		d	WMO	*dehogyis*	'on the contrary'	POA	Bandi
n-m		m-m	WMO	*köszönöm*	'thank you'	POA	Feri
m-t-t-m		t-t-t-m	WMO	*meg+mutat+ om*	'I show it'	POA	Feri
d-n-v-r		d-n-ð̃-r	WMO	*denevér*	'bat'	POA	Feri
v-d		d-d	WMO	*olvas+d#el*	'read it' IMP	POA	Pisti
r-b		b-b	WMO	*Lőri(nc)#bá(csi)+nak*	'to L. B.' an adult male	POA	Pisti
m-d		m-m	WMO	*mi+csoda*	'what'	POA	Pisti
ɟ-r		ɟ-ɟ	WMO	*gyere*	'come (here)' IMP	POA	Pisti
mt-d		p̃-p	WMO	*nem#tudom*	'I don't know'	POA	Zoli
tm	tm/ t̚m	mː	WCL	hát#meg+har ap+ja	'well, it bites it'	POA	Misi
oː		u	NUC	*ródsztá(r)*	'roadstar' brand name	SHO[58]	Pisti
zz	zː	z	SCL	*a(z)+za(l)*	'with that'	SHO	Ákos
ʃː		s	SCL	*tessé(k)*	'please'	SHO	Ákos
tt	tː	t	WCL	*ami(t)#te*	'what (rel.) you'	SHO	Ákos
tː		t	WFC	*ott#a*	'there is the (top of it)'	SHO	Ákos
zː		z̥	WFC	*vigyáz+z*	'beware'	SHO	Zoli
dː		d	WFC	*add#oda*	'give that'	SHO	Zoli
sː		s	WMO	*gyógyít+ás+s al*	'with cure'	SHO	Zoli
t t͡ʃ	t͡ʃː	t͡s	WCL	mi+t#csinál	'what is it doing'	SHO	Misi

58 Shortening

UR[11]	SR[12]	ASR[27]	PhE[13]	Sample[28]	Gloss	PhP[14]	Speaker[29]
r		j	MCL	*kér+het+ek*	’I can ask’	SIM[59]	Misi
ɒu		ɒː	NUC	*autó+t*	'car' ACC	SIM	Pisti
ɒu		ɒ	NUC	*autó*	'car'	SIM	Pisti
e-y-øː		e-u-oː	NUC	*repülő*	'airplane'	SIM	Zoli
ɒutoːt		oːtoːtoː	NUC	*autót*	'car' ACC	SIM	Zoli
gr		g	OCL	*Grundi(g)*	brand name	SIM	Pisti
nt͡sb	nt̬͡s̬b	d͜z̃[42]b	WCL	*Lőrinc#bácsi*	addressing an adult male	SIM	Misi
ldf	ld̥f	jt̚f	WCL	*emel+d#föl*	'lift it up' IMP	SIM	Misi
r		j	WFC	motor	'motorbike'	SIM	Misi
ʃ		s	WIO	*sajnál+om*	'I'm sorry'	SIM	Zoli
r		l	WIO	*rep+csi*	'airplane' DIM	SIM	Zoli
r		l	WIO	*repülő*	'airplane'	SIM	Zoli
l-r		j-j	WIO	*Lőrinc#bácsi*	addressing a male adult	SIM	Zoli
r		j	WMO	*szomorú*	'sad'	SIM	Misi
r		j	WMC	*verseny+autó +k+(ról)*	'about race cars'	SIM	Feri
r		j	WMO	*vacsorá+n*	'at dinner'	SIM	Feri
l-r- nt͡s		n-n-t͜s̃	WMO	*Lőrinc*	male name	SIM	Feri
ɲ		j	WIO	*nyer+tek*	'they won'	SPI[60]	Bandi
t͡ʃk		tk	MCL	*halacs+ka*	'fish' DIM	FOR	Pisti
ɒ-ɒ		ɒ		*az#a(nya)*	’the mother’	TRU[61]	Ákos
				te#szere(t+nél)	’you would like’	TRU	Ákos
				ke(ksz+et)	'biscuit' ACC	TRU	Ákos
				verseny+autó +k+(ról)	'about race cars'	TRU	Feri
				beteg+ség(et)#kap+t+ (am)	'disease' ACC	TRU	Misi
				(vil)lamos	'tram'	TRU	Zoli

59 Simplification
60 Spirantization
61 Truncation (underlying and surface representation forms are not transcribed)

UR[11]	SR[12]	ASR[27]	PhE[13]	Sample[28]	Gloss	PhP[14]	Speaker[29]
kjɒ		ki	NUC	*le+rak+j(a)*	's/he put (it) down'	TRU	Pisti
			NUC	*becsukj(a)*	's/he closes it'	TRU	Pisti
			WFC	*könyv*	'book'	TRU	Misi
				ké(r+ek)	'ask'	TRU	Ákos
ttm	tm/ t̚m	mː	WCL	itt#mi	'here what'	URS[62]	Misi
tn	tn/ t̚n	t̚n	WCL	mi+t#néz	'what is (s)he looking at'	URS	Misi
ldf	ld̥f	jd̥̚f	WCL	*emel+d#föl*	'lift it up' IMP	URS	Misi
t		t̬	CCL	*siker+ül+t*	'succeeded'	V[41]	Bandi
fr		f̬r	OCL	*frizbi+z+tünk*	'we played with frisbee'	V	Bandi
t͡sk		t̬͡s̬k̬	SCL	*palack+orr+ú*	'bottlenose' adj.	V	Bandi
p		p̬	WIO	*palack+orr+ú*	'bottlenose' adj.	V	Bandi
k		k̬	WIO	*kér+e(d)*	'you ask for it'	V	Zoli
k		k̬	WMO	*farok+uszony +a*	'fluke' POSS	V	Feri
k		k̬	WMO	*oda+rako+ (m)*	'I put it there'	V	Misi
k		k̬	WMC	*rak+juk#be*	'let's put it inside'	V	Misi
zt	z̥t	tː	CCL	*ez+t*	'that' ACC	VA[36]	Bandi
zt	z̥t	j̊t	CCL	*ez+t*	'this' ACC	VA	Feri
ɟf	ɟ̊f	d̥̪f	MCL	*nagy+fiú*	'big boy'	VA	Feri
ɟh	ɟ̊h	d̪h	MCL	*hogy+ha*	'in case'	VA	Feri
zt	z̥t	tː	MCL	*megáz+tat+ ok*	'you got wet in the rain'	VA	Misi
gs	g̊ʃ	sː	MCL	*beteg+ség(et)*	'disease'	VA	Misi
gh	g̊h	kː	MCL	*meg+harap+ ja*	'it bites him/her'	VA	Misi
dst	d̥st	ʃt	SCL	*ródsztá(r)*	'roadstar' brand name	SIM	Pisti

62 Unreleased stop

UR[11]	SR[12]	ASR[27]	PhE[13]	Sample[28]	Gloss	PhP[14]	Speaker[29]
zt	z̥t	z̥t	WCL	*ez#Tom+csi*	'this is T.' male name DIM	VA	Ákos
ɟsk	ɟ̊sk	ɟ̊sk	WCL	*egy#skorpió+nak*	'as a scorpion'	VA	Bandi
gh	g̊h	g̊	WCL	*még# hiány+z+ik*	'still missing'	VA	Misi
gk	g̊k	g̊k	WCL	*beteg+ség(et)# kap+t+(am)*	'I caught a disease'	VA	Misi
ɟt	ɟ̊t	tː	WCL	*egy#tükör+ben*	'in a mirror'	VA	Misi
ldf	ld̥f	jd̥̚f	WCL	*emel+d#föl*	'lift it up' IMP	VA	Misi
nt͡sb	nt̬͡s̬b	d͡z̰b̃	WCL	*Lőrinc#bácsi*	addressing an adult male	VA	Misi
bdk	b̥d̥k	d̥k	WCL	*dobd#ki*	'trash it' IMP	VA	Pisti
ɛl		ɛː	MCL	*fel+nőtt*	'adult'	VOC[54]	Feri
ɛg		ɛː	MCL	*meg+mutat+om*	'I show it'	VOC	Feri
ɔl		ɔː	MCL	*be+kapcs+ol+hat+om*	'I can turn it on'	VOC	Misi
kjɒ		ki	MCL	*le+rak+j(a)*	's/he put (it) down'	VOC	Pisti
kj		ki	MCL	*be+csuk+j(a)*	's/he closes it'	VOC	Pisti
ol		oː	MCL	*vol+t*	'was'	VOC	Zoli
aːl		aːː	SCL	*bálna*	'whale'	VOC	Bandi
ol		oː	SCL	*olvas+ni*	'to read'	VOC	Feri
ɒl		ɒː	SCL	*hatalmas*	'enormous'	VOC	Feri
ɛp		ɛː	SCL	*lepke*	'butterfly'	VOC	Misi
ol		oː	SCL	*olvas+d#el*	'read it' IMP	VOC	Pisti
ɛr		ɛː	SCL	*Energizer*	E. trademark	VOC	Pisti
ɒr		ɒː	SCL	*markolót*	'crane' ACC	VOC	Pisti
ɒr		ɒː	SCL	*Marci+ka*	male name DIM	VOC	Zoli
yl		yː	WCL	*örül+t+em*	'I was glad'	VOC	Bandi
ol		oː	WCL	*(h)ol#va(n)*	'where is it'	VOC	Feri
ɒj		ɒː	WCL	*baj#kicsi+t*	'problem to a small extent'	VOC	Misi

UR[11]	SR[12]	ASR[27]	PhE[13]	Sample[28]	Gloss	PhP[14]	Speaker[29]
ɒhh	ɒhh/h	ɒː	WCL	*ah+ho(z)*	’to that’	VOC	Misi
aːd		aːː	WFC	*zongorá+d*	’your piano’	VOC	Misi
oːt		oːː	WFC	*házikó+t*	'hut' ACC	VOC	Zoli
ɛm		ɛː	WFC	*nem*	'no'	VOC	Zoli
oro		oːː	WMO	*forog*	'spin'	VOC	Zoli
ol		oː	SCL	*volt+á(l)*	'you were'	VOC	Ákos
or		oː	SCL	*le+ford+ít+ja*	'turn it down'	VOC	Feri
ol		oː	WMC	*volt+á(l)*	'you were'	VOC	Ákos

8.2 The PSM segment inventories of Hungarian (based on Morén 2007b and Morén 2007c)

					Independent								Dependent	
					place			lar	manner					
			UR	SR	lab	cor	dor	lax	cl	o	lax	nas	cl	o
obstruent	stop	pless	t	t					√					
			d	d				√	√					
		p	p	p	√				√					
			b	b	√			√	√					
			c	c		√			√					
			ɟ	ɟ		√		√	√					
			k	k			√		√					
			g	g			√	√	√					
	fricative	pless	s	s						√				
			z	z				√		√				
		p	f	f	√					√				
			v	v	√			√		√				
			ʃ	ʃ		√				√				
			ʒ	ʒ		√		√		√				
	affricate	pless	t͡s	t͡s					√	√				
			d͡z	d͡z				√	√	√				
		p	t͡ʃ	t͡ʃ		√			√	√				
			d͡ʒ	d͡ʒ		√		√	√	√				
sonorant	mannerless	p	ʋ	v	√									
			j	j		√								
			ɰ	h			√							
	nasal	pless	n	n								√		
		p	m	m	√							√		
			ɲ	ɲ		√						√		
	liquid	pless	l	l					√				√	
			r	r					√		√		√	

Illustration 25: Consonant inventory in Hungarian (Morén 2007c, modified)

			Dependent place		Dependent manner	
			lab	cor	closed	open
//O//	/O/	[ɔ]				
//o://	/o:/	[o:]	✓			
//o//	/o/	[ɔ]	✓			
//e://	/e:/	[e:]		✓		
//e//	/e/	[ɛ]		✓		
//ø://	/ø:/	[ø:]	✓	✓		
//ø//	/ø/	[œ]	✓	✓		
//I://	/I:/	[i:]			✓	
//I//	/I/	[i]			✓	
//u://	/u:/	[u:]	✓		✓	
//u//	/u/	[u]	✓		✓	
//i://	/i:/	[i:]		✓	✓	
//i//	/i/	[i]		✓	✓	
//y: //	/y:/	[y:]	✓	✓	✓	
//y//	/y/	[y]	✓	✓	✓	
//E://	/E:/	[e:]			✓	✓
//E//	/E/	[ɛ]			✓	✓
???	/æ:/	[e:]		✓		✓
???	/æ/	[ɛ]		✓		✓
//a://	/a:/	[a:]				✓
//a//	/a/	[ɒ]				✓

Illustration 26: Vowel inventory in Hungarian (Morén 2007c)

8.3 Inventories and ASD speech patterns

8.3.1 Wolk and Edwards' (1993) segment inventory

	Word Position		
Sound Class	Initial	Medial	Final
Stops	p	p	(p)
	b	b	
	(t)		(t)
	d	d	
	(k)	(k)	
	g		
		ʔ	ʔ
Nasals	m	m	(m)
	n	n	(n)
Fricatives	(s)		(s)
	z		
	(ʒ)		
	h		
Affricates	((dz))		
Glides	w	w	
	((W̥))		
	j		
Liquids	(l)	(l)	

Illustration 27: B.D.'s phonetic inventory (Wolk and Edwards 1993)

8.3.2 Wolk and Giesen's (2000) segment inventories

	Child A 9.0 yrs	Child B 5.9 yrs	Child C 3.9 yrs	Child D 2.3 yrs
Stops				
Initial	p, t, k, b, d, g	Absent	p, t, k, b, d, g	k, b, d, g
Medial	p, t, k, b, d, g	Absent	p, t, k, b, d, g	b, d, g
Final	p, t, k, b, d, g	Absent	p, t, k, b, d, g	
Fricatives				
Initial	f, s, ʃ, v, z	Absent	f, θ, s, ʃ, h	ʃ, h
Medial	f, s, ʃ, v, z, ʒ	Absent	f, θ, s	
Final	f, s, ʃ, v, z, ʒ	Absent	f, θ, s, ʃ, v, ð, z	θ, ʃ
Affricates				
Initial	ʧ, dʒ	Absent	(tʃ), (dʒ)	
Medial	ʧ, dʒ	Absent		
Final	ʧ, dʒ	Absent	(tʃ)	[tθ]
Nasals				
Initial	m, n	[ŋ]	n	
Medial	m, n		n, ŋ	
Final	m, n	ŋ	n, ŋ	
Liquids				
Initial	l, r	Absent		
Medial	., r	Absent	l	(l)
Final	l, r	Absent	l	
Glides				
Initial	w, j	j	w, j	w, j
Medial	w, j	j	w, j	w, j
Final				

Illustration 28: Phonetic inventories of four ASD siblings (Wolk and Giesen 2000)

Child A (9.0 yrs)	Child B (5.9 yrs)
■ Almost full phonetic inventory, except for: velar nasal /ŋ/, fricative /θ, ð/ in all positions ■ In liquid clusters, liquid is always deleted, e.g., fl → [f], kl → [k], skr → [kr,] str → [st]	■ Severely restricted inventory ■ Frequent laryngeal noises ■ Restricted use of vowels [i] [u] [ʌ] ■ Vocables, e.g., [iuiu], consistently used to signify distress or sadness ■ Repetitive use of high-pitched vowel [I] to signify contentment or pleasure ■ Evidence of one glide [jʌ] ■ Evidence of one nasal sound [ŋ]. This occurs in word-final position and word-initial position non-English [ŋ] in [ŋʌŋ] for "no" ■ /m, n/ are absent

Illustration 29: Summary of phonetic inventory data 1 (Wolk and Giesen 2000)

Child C (3.9 yrs)	Child D (2.3 yrs)
■ Moderately restricted inventory ■ All stops present in all positions ■ Voiceless fricatives present in all positions, voiced fricatives present only in final position ■ Voiceless affricative /tʃ/ evident in word initial and final positions ■ Nasals, liquids /l/ and glides present except bilabial /m/ is absent	■ Moderately to severely restricted inventory ■ Voiced vowels [a, ʌ, ɑ, I, e, ɔ, u, ai, ɘ] ■ Evidence of all voiced stops in word initial and medial position. Voiceless /k/ in word initial position only. ■ Evidenceof three fricatives /θ, ʃ, h/; /θ/ only in word final position; /ʃ/ in word initial and final position ■ Evidence of both glides /w, j/ ■ Evidence of one non-English affricative /tθ/ in word final position. All English affricates absent. ■ All nasals absent

Illustration 30: Summary of phonetic inventory data 2 (Wolk and Giesen 2000)

8.3.3 Speech patterns in Cleland et al (2010)

Target	Transcription	Error type	Process
house	[haʊfŋ̊]	Non-developmental	Phoneme specific nasal emission
swimming	[fŋ̊ɪmɪn]	Non-developmental	Phoneme specific nasal emission
spoon	[fŋ̊pʉn]	Non-developmental	Phoneme specific nasal emission
fishing	[fɪsɪn]	Developmental	Post-alveolar fronting
jumping	[ʒʌmpɪn]	Developmental	Deaffrication
flowers	[faʉʌɹz]	Developmental	Cluster reduction
glasses	[gwasɪz]	Developmental	Gliding
telephone	[tɛwɪfon]	Developmental	Gliding
flowers	[faʉʌɹz]	Developmental	Cluster reduction
rabbit	[wabɪt]	Developmental	Gliding
blue	[bʉ]	Developmental	Cluster reduction
knife	[m̥ːaɪf]	Non-developmental	Labialized and prolonged
brush	[gw̥ʌs]	Non-developmental	Backed
shovel	[çʌdl̩]	Non-developmental	Palatalized
tree	[çi]	Non-developmental	Palatalized

Illustration 31: Examples of ASD speech patterns (Cleland et al 2010)

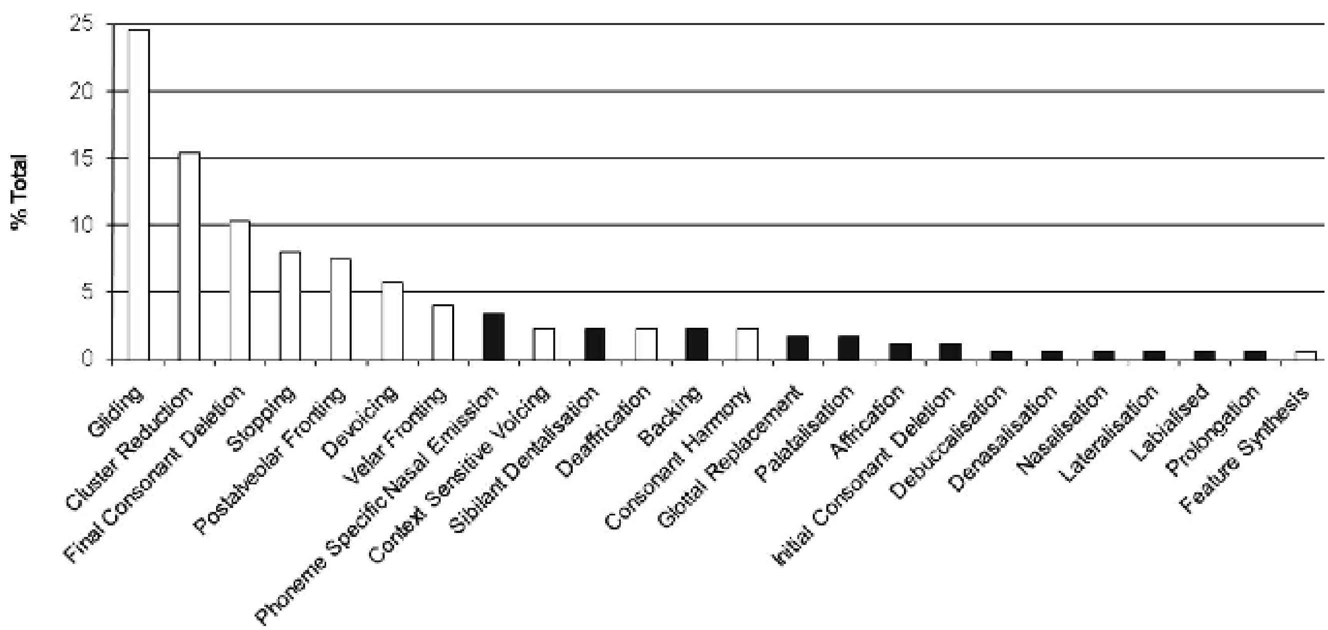

Illustration 32: Frequency of phonological process types. White bars indicate developmental, black non-developmental phonological processes (Cleland et al 2010).

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