1. Introduction

1.1. General

In any natural language, there are certain constraints on the combinatory possibilities of phonemes, their positions of occurrence and possible order. In English for example, if a syllable-initial consonantal cluster has three elements, the first must be /s/, the second must be a voiceless stop and the third must be a liquid or glide (Edwards & Shriberg 1983: 28). In Finnish, if a syllable-final consonantal cluster has two members, the first member is always a nasal or liquid and the second member is a voiceless obstruent (Wiik 1981: 270). Traditionally this sort of tactic behaviour of phonemes and/or, as Goldsmith (1996: 1) puts it, conditions on well-formed words, have been called *phonotactics*. The term *phonotactics* was introduced to the linguistic literature by Robert Stockwell (Hill 1958: 68).

Different languages have different rules that govern the distribution, arrangement and combination of phonemes in syllables, morphemes and words; even if they have an identical inventory of phonemes. For example, Lass (1984: 23) states that "both standard North German and English have stop systems that can be represented /p, b, t, d, k, g/ and both have the sibilants /s, z, ʃ/, but whereas these are all distributed quite freely in English, in German none of the voiced ones may appear word-finally". Similarly while both English and Italian permit syllable-initial two-member consonant clusters and both have /z/ and /v/ in their consonant inventories, English contrary to Italian does not permit the /zv/ cluster (Hawkins 1984: 58).

Phonotactic constraints are not just language-specific restrictions. There is evidence that certain universal tendencies are involved in the ways that languages organise segments into syllables.

Speakers are said to be intuitively aware of the phonotactic constraints and related rules of the languages they speak. Jusczyk *et al.* (1993: 402-420 and 1994: 630-645) claimed that by nine months of age, infants have picked up some information about the phonotactics of their native languages. Infants utilise this information to discover words, learn words from parental speech and identify word boundaries.

Research in phonotactics is important to several fields other than descriptive linguistics. To name a few: automatic speech and language recognition, speech audiometry, cryptography and shorthand writing.

One central goal of this study is to investigate the phonotactics of Modern Persian. The study is limited to examining phonotactic restrictions on the level of a syllable. This is a step towards defining what well-formed words are like in Modern Persian, since well-formed words consist at the very least of well-formed syllables, as Goldsmith (1996: 5) notes. Word-level phonotactics, including restrictions on the combinations and distributions of syllables in words, is outside the scope of this study.

By Modern Persian, I mean a fairly typical literary Persian based on the Tehrani dialect. This is the variant which is used normally in official speeches and in news reports on the Iranian radio and television. The dialect of Tehran is usually considered to be the standard[1] and the most prestigious variety of Persian in Iran.

1.2. Methodology of phonotactic studies

Malone's (1936) study of the phonemic structure of English monosyllables introduces the method of analysing phoneme combinations. Malone studied separately the phoneme combinations allowed in initial, medial and final positions and formulated the following three types of delimitative rules for each of these positions:

(1) restriction in membership
(2) restriction in sequence of members

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[1]   Some Iranian linguists, e.g. Deyhim (1988: 27) do not recognise any standard Persian.

(3) restriction in number of members

In 1939, Trubetzkoy in his *Grundzüge der Phonologie* discussed the methods of studying phoneme combinations and distributions on a more comprehensive level. Trubetzkoy supported a method as uniform as possible for all languages despite their diversity. He emphasised that application of a uniform method was "not only desirable but absolutely necessary... since a comparison between various language types can only be pursued under this condition" (Trubetzkoy 1969: 248).[2] Trubetzkoy's principles underlying a uniform method for the study and investigation of combinations were based on Malone's method. Trubetzkoy (1969: 249) set two tasks to be accomplished before the investigation of combinations:

(1) determination of the phonological unit within which combinatory rulescan be studied most appropriately

(2) suitable division of the "frame units" with respect to their phonological structure

Phonostatistics was also recommended for use as a tool of investigation (Trubetzkoy 1969: 256). This tool is exploited extensively throughout the present study.

The idea of "frame units" is also discussed in Pike (1947). Pike suggests that phoneme distribution should be studied in relation to the following units:

1. Utterances
2. Words
3. Morphemes
4. Syllable structures
5. Nonsegmental characteristics (Pike 1947: 182-184) [3]

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2   The version used here is an English translation of *Grundzüge der Phonologie* published in 1969. See the bibliography.

3   The following is a list of some phonotactic studies that have used utterance, word, morpheme and syllable as units of reference, and the languages on which these studies have been carried out:

Utterance: Harris (1951), English, Swahili

Word: Kruisinga (1942), Trnka (1966), Hawkins (1984), English
         Lazard (1992[1957]), Persian
         Sigurd (1965), Swedish

The issues Malone and Trubetzkoy discussed in their methods deal with very important questions linguists seek to answer when they investigate phonotactic structures, and for this reason they have been applied in many phonotactical studies. The method used for this study is also mainly based on the guidelines set out by Malone and Trubetzkoy. I have also benefited from the studies of Trnka (1966 [1935]), Vogt (1942, 1954), Harary and Paper (1957), Spang-Hanssen (1959), Sigurd (1955, 1965), Karlsson (1982), Samareh (1977, 1985), Majidi (1986), and Bakró-Nagy (1992).

The basic selected for this part of my study is the syllable (See 1.3). According to Haugen (1956: 216), the syllable is "the most convenient framework for describing the distribution of phonemes". He also emphasises that "those who attempt to avoid the syllable in their distributional statements are generally left with unmanageable or awkward masses of material" (1956: 217). Although Haugen's view of the syllable somewhat oversimplifies of the problem, and it may not be the best possible choice, especially when syllable boundaries are ambiguous, it proves to be the most convenient frame of reference as far as Persian is concerned.

1.3. The syllable

Although the notion of syllable often seems to be self-evident to native speakers, its technical definition is anything but self-evident. There are linguists in whose opinion a syllable is no more than a convenient fiction and others who have expressed doubt about its necessity.[4]

Evidence for the syllable is plentiful, although we are still without a satisfactory definition of it. It has been noticed that in many languages native

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Bakró-Nagy (1992), Proto-Uralic and Proto-Finno-Ugric
Syllable: Vogt (1942), Norwegian
    Klausenburger (1970), French
    Allen (1973), Latin and Greek
    Samareh (1977), Persian
    Bauer *et al.* (1980), English
    Devine & Stephens (1994), Greek
    Wiik (1977), Finnish
Word, Morpheme, Syllable: Karlsson (1983), Finnish

[4] For example Kohler writes (1966: 207): "it can be demonstrated that the syllable is either an UNNECESSARY concept...or an IMPOSSIBLE one...or even HARMFUL."

speakers can determine the number of syllables in any utterance in their language, often, in Bell and Hooper's (1978: 3) words, "inviting the assumption that this is a fundamental justification for the unit". Hála (1961: 73) points out that people without linguistic knowledge can divide words into syllables; and people who suffer from subcortial motor aphasia make as many expiratory movements as there are syllables. He also emphasises that no matter how slowly one speaks, syllables maintain their existence and one's speech is never decomposed into separate segments.

Liberman *et al.* (1974: 208-209) claim that syllables are the first linguistic units that appear in the course of language acquisition. According to Jusczyk 1994: 257), syllables are accessible earlier than phonemes. In many languages the syllable plays a major role in verse rhythm.[5]

Traditionally, efforts to explain the concept of the syllable have proceeded either from the phonetic or phonological direction. From a phonetic point of view, attempts have been made to define the syllables of a language "on the basis of the articulatory effort needed in order to produce them" (Crystal 1985). The first modern phonetic definition was Stetson's "pulse or motor theory". The motor theory characterises the syllable as a sequence of sounds produced with the air from a single chest pulse. But Ladefoged (1967: 20) has shown that there are cases where two chest pulses may be associated with a single syllable, and others in which a single chest pulse may span two syllables. Falk (1978: 105) also points out that this theory will create difficulties when trying to clarify separation points between the syllables of an utterance.

An alternative phonetic approach focuses, in Goldsmith's (1990: 104) words, "on the alternating crescendo and diminuendo of speech, the oscillating rises and falls of energy". This sonority view of the syllable finds a clear statement in Bloomfield's *Language:*

> In any succession of sounds, some strike the ear more forcibly than others: differences of sonority play a great part in the transition effects of vowels and vowel-like sounds... In any succession of phonemes there will thus be an up and

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[5] For example: "The basis of Classical Persian prosody is the division of syllables into short and long (overlong) syllables. In order to perceive the rhythm and appreciate the different metres one must therefore be able to distinguish between long and short syllables" (Thiesen 1982: 3).

down of sonority... Evidently some of the phonemes are more sonorous than the phonemes (or the silence) which immediately precede or follow... Any such phoneme is a crest of sonority or a syllabic; the other phonemes are non-syllabic... An utterance is said to have as many syllables (or natural syllables) as it has syllabics. The ups and downs of syllabification play an important part in the phonetic structure of all languages. (1970: 120-121)

The theory of sonority is based mainly on auditory judgements. It offers a useful general guideline and explains, as Ladefoged (1975: 220) points out, "why people agree on the number of the syllables in the majority of words". However, the sonority principle is not without exceptions, as Ladefoged (1975: 220), among others, has noted. English, for example, has monosyllables such as *spit, strike, skin,* where the most sonorous element, /s/, is at the margin and is followed by a less sonorous segment, a stop. The fricative /s/ can also occur word finally after a stop, as in *sits*.

Based on the theory of sonority, it has been proposed that the nucleus contains the most sonorous segment, and the sonority decreases towards the syllable margins[6], as the following figure displays:

Margin ————————— *sonority*   (Nucleus)   *sonority* ————————— Margin
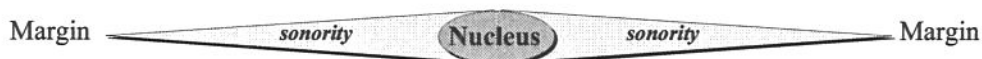
The idea of the sonority hierarchy is traced back at least to the final part of the last century, to scholars such as Sievers (1881). Saussure (1915 [1960]: 49-60) formulated a definition of the syllable on the basis of the degree of opening of the sounds. He stated that the most open sounds occur at the syllable nucleus and the least open sounds occur at the margins. According to Hooper (1976: 198) "a classification of segments on the basis of opening yields results similar to a classification on the basis of sonority".
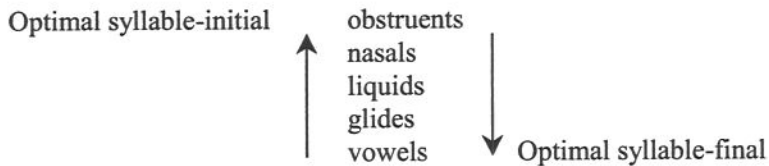
Jespersen (Malmberg 1963: 66), suggested that "phonemes group around the most sonorous phoneme (often, but not always, a vowel) according to their

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[6]   This principle is called *Sonority Sequencing Principle* (Kenstowicz 1994: 254).

degree of sonority". He classified sounds according to their degree of sonority in the following way (beginning with the least sonorous):

1. Voiceless consonants
    a. Stops (p, t, k)
    b. Fricatives (f, s, etc.)
2. Voiced stops (b, d, g)
3. Voiced fricatives (v, z, etc.)
4. Nasals and laterals (m, n, l, etc.)
5. Trills and flaps (r)
6. Close vowels (i, y, u)
7. Semi-close (mid) vowels (e, o, etc.)
8. Open vowels (a, etc.)

Another model for the arrangement of segments in the syllable, that has its roots at least on the models proposed by Saussure and Jespersen, is that of Hooper (1976: 196). According to Hooper there is an optimal ordering of elements with respect to a syllable-peak which shows up as a very common pattern cross-linguistically. The following is the "hierarchy of suitability for initial and final positions" of the syllable, as Hooper proposes (1976: 196):

Optimal syllable-initial ↑   obstruents
                              nasals
                              liquids
                              glides
                              vowels ↓   Optimal syllable-final

In other words the order of segments in a syllable, assuming that the onset is the mirror image of the coda, is:

obstruents - nasals - liquids - glides - VOWELS - glides - liquids - nasals - obstruents

Croft (1990: 122) accepts in principle the sonority hierarchy proposed by Hooper, but he revises it in the following way (< means the order is absolute; ?< means that the order is dominant):

Sonority(revised)
obstruents, nasals ?< liquids < glides < vowels

Hall (1992: 64) argues for the following sonority hierarchy for German:

   obstruents < nasals < 1 < R < vowels

Carr (1993: 198) has also postulated the following sonority hierarchy among segment types ('>' means 'is more sonorous than'):

   a > e, o > i, u > r > 1 > m, n > ð, v, z, ʒ > θ, f, s, ʃ > b, d, g, > p, t, k

As the examples above show, the continuum behind the hierarchies is the same, but the proposals differ as to the points on the continuum that mark changes in degrees of sonority. In some hierarchies, segments within each major class, such as obstruents, or vowels, are considered to have the same degree of sonority, and the major classes are only ranked with respect to sonority. In others, subclasses (such as voiceless vs. voiced stops; open vs. mid vs. close vowels) are ordered hierarchically, and still others contain rankings of individual segments in addition to segment classes. Hall (1992: 64) presents a sonority hierarchy specifically for German, thus implying that languages can differ as to which difference on the sonority scale they are sensitive to in their phonological systems.

Phonetic approaches try to define the syllable from an articulatory or an auditory standpoint and attempt to provide a definition which is universal and valid for all languages. Pulgram (1970: 20), while accepting the phonetic reality of a syllable boundary, suggests that "the notion of a universal and specific phonetic signal of syllabicity" must be abandoned.

Phonologists in structural linguistics were interested in finding a specific functional definition of a syllable with reference to the structure and distributional system in individual languages rather than in general terms with universal applications. In Fudge's view (1969: 254), the phonological syllable fulfils two chief functions. The first is to act as the domain of linguistically relevant prosodic properties such as pitch, and the second is to give a basis for organising and expressing constraints on possible phoneme sequences. O'Connor (1973: 201), however, does not support the idea of a phonological syllable, since he claims that "the phonological view of the syllable requires a separate

definition for each separate language. There is no universal phonological syllable." [7]

As the previous discussion suggests, the syllable was a central unit in structuralist phonology. However, generative phonology, as presented in Chomsky & Halle (1968), did not recognise the syllable as part of its theory; the syllable showed up only in informal treatments.[8] The idea of the sonority hierarchy was likewise missing in the generative theory. The need for the unit syllable in a phonological theory was made plain, e.g. in Fudge (1969), while Hankamer & Aissen (1974) argued for the necessity of a sonority hierarchy in descriptions of certain natural language processes. Later, nonlinear approaches, such as autosegmental phonology, have accepted both the syllable and the idea of the sonority hierarchy. [9]

Non-linear approaches have also revived the traditional structuralist way of looking at the syllable in terms of constituent structure. One way is to analyse the syllable as a hierarchical structure is as follows (van der Hulst 1984: 52): The syllable is a binary branching structure that consists of onset and rhyme, and the rhyme consists of nucleus and coda. The nucleus is typically occupied by a

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[7]   In addition to phonetic and phonological approaches, there is another approach that defines a syllable as a "unit of neural programming which can be reconstructed by the hearer from a variety of clues, in spite of the absence of any single phonetic correlate" (Trask 1996: 345). In Fry's (1964: 219) words, "the brain mechanism ...arranges the time scheme for a complete syllable as a unit". Similarly Lehiste (1971: 159) writes:
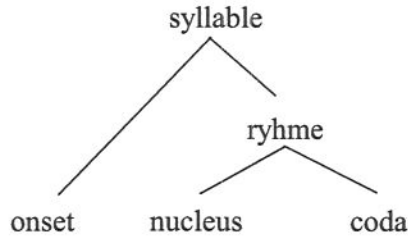
> If an error is made in the duration of one phoneme, the error is largely compensated for in the following phoneme, which finishes at the originally planned time, despite the fact that it started late. This.... suggests that articulatory events are programmed... not in terms of single phonemes, but in terms of higher-level articulatory units.

Sommerstein (1977: 200) comments that "if this approach to the problem of the syllable is anywhere near correct, it is both futile to attempt to define the syllable on a phonetic and/or phonological basis and wrong to conclude that, because this cannot be done, the syllable is not a useful concept in phonology".

[8]   The feature system in Chomsky & Halle (1968) contains a feature [+vocalic], but it is a property of the nuclear element only. Harms (1968: 25) mentions a manuscript by James McCawley, who argues for a feature of syllabicity to replace the feature of vocalicity. Harms himself uses the feature *syllabic* in his textbook.

[9]   The sonority hierarchy does not enjoy unanimous acceptance; it is very severely criticised by Ohala (1990), who claims that it is without any phonetic foundation and that its use results in circularity.

vowel, the onset contains the preceding consonant(s), and the coda contains the following one(s). This structure is pictured as follows:

```
                    syllable
                   /      \
                         ryhme
                        /    \
    onset        nucleus       coda
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Another way to analyse the syllable is to see it as a flat structure, i.e. without the constituent rhyme (van der Hulst 1984: 51). Here, the syllable consists of three parts: nucleus, onset, and coda. The difference between these analyses is that the former (i.e. the hierarchical structure) predicts that nucleus and coda are more closely connected than nucleus and onset. For example, there may be restrictions between nucleus and coda, but not between onset and nucleus. Moreover, the rhyme in poetry involves the nucleus and the coda, but leaves the onset outside. The flat structure, on the other hand, sees onset and coda as equally closely connected with the nucleus, as shown in the following figure:

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                    syllable
                  /    |    \
    onset        nucleus       coda
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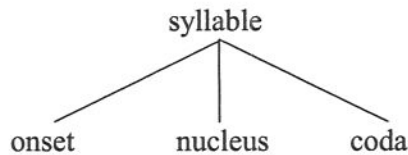
Syllable types vary greatly across languages. Blevins (1996: 217) illustrates the variation with the aid of eleven languages and ten syllable types, which range from the length of one segment (V) to five segments (CCVCC and

CVCCC). The variation of the nucleus is disregarded in this illustration, and the number of onset consonants is at most two. This means that the number of possible syllables in a language is well above ten.[10] Some languages have heavy constraints on the syllable type, while others are more permissive. One of the example languages, Hua, permits only one syllable type, CV. It is assumed that all languages have CV syllables, that it is a universal. Some example languages do not permit any coda consonants, while some others do not permit complex codas (i.e. more than one consonant in the coda), or complex onsets. English is given as an example of a language that permits all the ten syllable types. In addition to the CV universal, Blevins mentions some implicational universals, e.g. if a language permits onsets/codas with n consonants, it also permits onsets/codas with n-1 consonants.

1.4. Previous studies of the Persian phoneme inventory, syllable system and phonotactics
1.4.1. Phoneme inventory
1.4.1.1. Consonants

The Persian consonant inventory has not recently been an issue of controversy.[11] There are 23 phonemes[12], as shown in Table 1.1 (Meshkotod Dini 1995: 83).[13]

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[10]   Dutch, for examples, has fifteen syllable types (Schiller 1997: 38).
[11]   In older literature we find some discussions on the phonemic status of /ʔ/ and /w/. Mathews (1956: 4) claims that /ʔ/ is not "strictly" a part of the Persian consonant system and often lapses in all positions. Krámský (1939-41: 75) suggests that /ʔ/ has lost its distinguishing power and has become a mere lengthening sign of the preceding vowel. Samareh (1985: 63-65) writes: "Lengthening the preceding vowel is a characteristics of a weak variant of /ʔ/". A good discussion on the phonemic status of /ʔ/ is in Samareh (1985: 63-65). With regard to the phonemicity of /w/, Hodge (1951: 357) and Strain (1969: 56) believe that /w/ is a member of the consonant inventory of Persian, but has a limited distribution. Obolonsky *et al.* (reported in Ruhlen 1975: 256) include /ʔ/ in their list of consonants of Persian. According to Thackston (1978: 26), [w] is an allophone of /v/. Samareh writes (1985: 121-122): " w belonged to the inventory of Persian phonemes at the earlier stages of Persian. Later on it changed to v, which is the nearest consonant to w in place and manner of articulation". In this study, /w/ does not belong to the inventory of the consonant phonemes of Modern Persian. Another short discussion on /w/ will be in 1.4.1.2.
[12]   In Modern Persian some of the consonants may be orthographically represented with up to four different letters. For example the consonant /z/ is represented by the following characters: ض، ظ، ذ، ز. The reason why certain phonemes have multiple characters is that Modern Persian has preserved the orthographic form of the absolute majority of Arabic

From a typological point of view, the consonant system of Persian is of average size.[14]

Table 1.1: *Consonants of Modern Persian*

Manner of articulation		Bi-labials	Labio-dentals	Dento-alveolars	Alveolars	Alveo-palatals	Palatals	Velars	Uvulars	Glottals	
Stops	voiceless	p		t				k			ʔ	4
	voiced	b		d				g	G			4
Affricates	voiceless					č						1
	voiced					ǰ						1
Fricatives	voiceless		f		s		š			χ	h	5
	voiced		v		z							3
Liquids	trill				r							1
	lateral				l							1
Nasals		m			n							2
Glide							y					1
Total		3	2	2	5	2	3	2	2	2	23

All obstruents except uvulars and glottals appear in pairs as voiceless/voiced. The phonemes that do not appear pairwise are the voiceless /ʔ/, /χ/ and /h/ and the voiced /G/.

1.4.1.2. Vowels

The vowel system of Persian has six[15] phonemes. Typologically speaking, the size of the Persian vowel inventory is somewhat smaller than the average.[16] Following figure (next page) shows the vowel phonemes of Modern Persian.[17]

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loanwords in their original shape, despite the fact that they have all been persianised phonologically. The four letters which signify the phoneme /z/ each represent separate phonemes in Arabic. In this study the attention was directed exclusively to the phonemic representation of the data, not their orthographic form.

[13] Meshkotod Dini uses /x/ for the voiceless uvular fricative and /q/ for the voiced uvular stop. In this study they are replaced with their ordinary phonetic symbols /χ/ and /G/.

[14] According to Maddieson (1986: 9), "the total number of consonants in an inventory varies between 6 and 95 with a mean of 22.8" . Décsy (1987: 57) registers the following: "The number of consonants in a language varies between seven and about sixty. However the number of consonant phonemes in most languages does not exceed 20 to 30".

[15] In Hodge's list of the vowels of the standard spoken language of Tehran, /ə/ has also been included. According to Hodge "it has been noted only in informal speech [of the
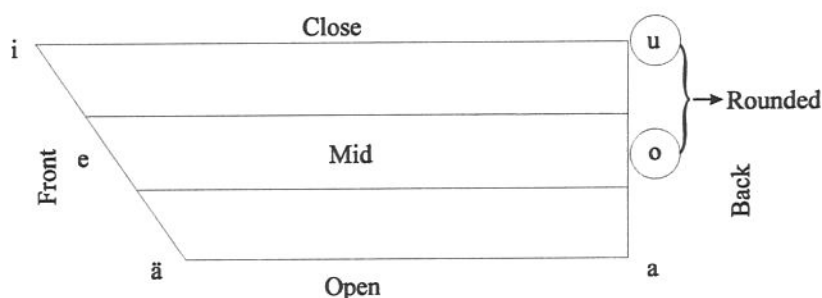
Traditionally, Persian vowels have been categorised into two groups: long and short.[18] According to this categorisation, /i, u, a/ are considered long vowels, and /e, o, ä/ short vowels. Laboratory investigations corroborate this dichotomy (Strain 1969: 204).[19] However, in some phonological environments the length of the short vowels may be longer than that of the long vowels. For example, in the word /därd/ 'pain' the vowel /ä/ is longer than the vowel /a/ in the word /gaz/ 'gas, biting' (Samareh 1985: 102). Similarly the vowel /ä/ in the word /säbr/ 'patience' is pronounced longer than the vowel /i/ in /mi-ko-näm/ 'I do' (Thiesen 1982: 5). Long vowels are also called "stable vowels" and short vowels "unstable". According to Rubinchik (1971: 26), this is because "long vowels retain their qualitative stability regardless of the influence of neighbouring sounds; short vowels influenced by neighbouring sounds, in fluent conversation,

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standard spoken language of Tehran], with /a/ following in the next syllable. Examples: /bahár/ 'spring', /dahán/ 'mouth', /taharæt/ 'cleanliness', /mahaseré/ 'surrounded', /šamá/ 'you', /nahár/ 'lunch'. In each instance a different vowel may occur in formal style" (1951: 357-358). What Hodge is referring to may be interpreted as an example of a phenomenon called by Bloch (1941: 278-284) "complete phonemic overlapping"; that is, the phone [ə] is the allophone of three different phonemes, /a, ä, o/, in identical environments (i.e. when followed by a syllable with /a/ as nucleus).

[16] According to Maddieson (1986: 9), the total number of vowels (in an inventory) varies between 3 and 46 with a mean of 8.7.

[17] This figure is based on the diagram of the Persian vowels in Meshkotod Dini (1995: 22). The symbols Meshkotod Dini has used for front open and back open vowels (i.e. /a/ and /â/) have been replaced here correspondingly with /ä/ and /a/.

[18] See, for example, Shaki (1957: 4), Rubinchik (1971: 26), Windfuhr (1992: 183), and Pournamdarian (1993: 4).

[19] On the basis of laboratory tests, Strain has registered the following figures on the overall duration of each Persian vowel (in centiseconds): /a/ (15.5), /u/ (11.3), /i/ (10.7), /ä/ (10.3), /o/ (10.2), and /e/ (9.8).

may occur in different qualitative variants". Quantitative length of the vowels is not distinctive in Persian.[20]

The existence or nonexistence of diphthongs in Persian is a controversial issue. While linguists such as Lambton (1967: xiv), Moinfar (1973: 20), Thackston (1978: 23-24), Djavadi (1984: 26) and Pournamdarian (1993: 4) ascribe one to five diphthongs to Persian, some others for example Krámský (1939: 71-72), Samareh[21] (1985: 117-123), Lazard (1989: 265), Meshkotod Dini (1995: 78) and Najafi (1996: 62), argue that the suggested diphthongs are in fact combinations of two different phonemes and thus they should be considered diphonemic and not monophonemic. The suggested diphthongs are as follows:

Diphthongs	Examples
/uy/	/muy/ 'hair', /kuy/ 'alley, district'
/oy/	/χoy/ 'name of a city in Iran'
/ay/	/nay/ 'windpipe, trachea', /čay/ 'tea', /pay/ 'foot'
/ey/	/mey/ 'wine', /pey/ 'foundation, groundwork'
/ow/	/now/ 'new', /dow/ 'jogging', /ǰelow/ 'front'

The supporters of the no-diphthong approach base their arguments on the criteria Trubetzkoy (1969: 56-59) set out for distinguishing monophonemic diphthongs from diphonemic diphthongs. According to one of Trubetzkoy's criteria (1969: 56), "only those combinations of sounds whose constituent parts in a given language are not distributed over two syllables are to be regarded as the realisation of a single phoneme". In the light of this criterion, all of the

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[20] "Classical Persian had three short vowels: *a, i, u*; five long vowels: *ā, ī, ū, ē, ō*, and two diphthongs: *ai* and *au*... In Modern Persian a distinction of vowel quality has taken the place of the Classical Persian distinction of vowel quantity and the number of vowel phonemes has been reduced." (Thiesen 1982: 3).

[21] Samareh's position concerning the diphthong of Persian seems to be in a process of continuous development. In *The arrangement of segmental phonemes in Farsi* (Samareh 1977), Samareh supports the phonemic status of /ei/ and /ou/. In another book, *Avashenasi-ye zaban-e Farsi* (Samareh 1985), he rejects the existence of any phonemic diphthong altogether (Samareh 1985: 117-123). However, when discussing the inventory of Persian consonants and vowels, he states: "There are eight vowels in Persian: i, â, e, u, o, a, ou, ei" (1985: 39). The same statement is repeated in his two other publications, *Persian language teaching*, books one (Samareh 1987: 26) and three (Samareh 1988: 27).

diphthongs listed above may then be interpreted as combinations of two phonemes as their constituent separate when they are followed by a vowel. For example:

Diphthongs	Examples
/uy/	/muy/ +/i/ → /mu-yi/ 'a hair'
/oy/	/χoy/ + /i/ → /χo-yi/ 'from χoy'
/ay/	/pay/ + /äm/ → /pa-yäm/ 'my foot'
/ey/	/pey/ + /äš/ → /pe-yäš/ 'its foundation'
/ow/	/now/ + /in/ → /no-vin/ 'new, modern'

According to Samareh (1985: 122), Meshkotod Dini (1995: 77-78) and Najafi (1996: 62), the second part of the diphthong */ow/ i.e. [w] is an allophone of the phoneme /v/. Meshkotod Dini (1995: 77) introduces the following rule for the realisation of /v/ as [w]: v → w / o ⎯ . I do not assume any phonemic diphthong for Modern Persian in the present study.[22]

1.4.2. Syllable system

The Persian syllable system has been a controversial issue. Krámský (1939: 79) categorised Persian monosyllabic words into six types: V[23], VC, CV, VCC, CVC, and CVCC. This system will hereafter be referred to as (C)V(C)(C) system.[24] In another article (Krámský 1948: 107 & 116), he added three more types, CVV, CVVC, and VVC to the above mentioned list. According to Krámský the latter three types are exclusive to words of Arabic origin.

Nye's (1954: 17) system of Persian syllables included – in addition to all six types Krámský introduced in 1939 – one more type, CVCCC. Nye claimed that the CVCCC type is found only in words such as */tämbr/; i.e. in words of French origin. However, in Modern Persian, all loanwords with syllable internal clusters of three consonants pass through a process of cluster reduction. As a

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22   For detailed discussions on the diphthongs of Modern Persian the reader may refer to Samareh (1985), Meshkotod Dini (1995) and Najafi (1996).

23   In Krámský's articles "a" stands for "V" and "b" stands for "C".

24   Several studies have been made on the basis of this typology. See Krámský (1939: 75-80), Nye (1954), Bateni (1975: 159), and Majidi (1986).

result, *tämbr* is pronounced /tämr/, *desambr* is pronounced /desamr/ and *orkestr* is pronounced /ʔorkesr/ etc.

A major question with the (C)V(C)(C) system is the ambiguity of syllable boundaries. To solve this problem Majidi (1986: 81) – whose study of the phonotactics of Persian is based on this system – proposed the following rules:

(1) The inter-vocalic consonant belongs to the following syllable.
(2) The second consonant of the inter-vocalic consonant cluster belongs to the following syllable.
(3) Two adjacent vowels belong to two different syllables.

A somewhat similar solution was proposed by Rubinchik (1971: 34).

The basic problem with these rules is that they are arbitrary, not natural. Majidi gives the example /mäGaze/[25] for the first rule and syllabifies it as /mä-Ga-ze/. This syllabification agrees with the rules he has set. However, there is no natural reason in the (C)V(C)(C) system why the word in question should not be syllabified as /mäG-a-ze/, /mä-Gaz-e/ or /mäG-az-e/, since combinations such as /mäG/ and /Gaz/ are permissible and quite common in Persian and since Majidi has the syllable type V in his system. The same is true with regard to other examples Majidi gives in connection with his other rules as well.

Jazayery & Paper (1961: 39) reduced the number of Persian, syllable types to three: CV, CVC, and CVCC, summarised hereafter as CV(C)(C). This implied an important theoretical decision, namely, that "the vocalic onset of words and syllables is identified with a phonemic glottal stop plus vowel" (Windfuhr 1979: 143). Scott (1964: 27-30), in his article *Syllable structure in Teheran Persian,* elaborated this new approach and supported it. Scott's discussion included a brief report of his instrumental examination with regard to the status of /ʔ/ in the initial position. Similar investigations with supportive results have also been carried out by Samareh (1985: 63-65 & 128-130; 1977: 15-22).

Najafi (1996: 65) suggests a six-type syllable system that is based on the Jazayery & Paper (1961) CV(C)(C) system, but takes into consideration the length of the vowels as well. In other words, in Najafi's system each of the CV,

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[25]   Majidi's transcription of this word is /maġāzé/ (1986: 81).

CVC and CVCC syllable patterns has two forms: one with a short vowel, the other with a long vowel, as follows: [26]

Syllable patterns	Examples
CV̌	/nä/, /to/, /ke/
CV̄	/ma/, /χu/, /si/
CV̌C	/kär/, /pol/, /del/
CV̄C	/kar/, /mur/, /sir/
CV̌CC	/kärd/, /goft/, /zešt/
CV̄CC	/kard/, kušk/, /riχt/

Najafi does not say anything about his motivation to introduce this system and what the advantages of this system are (if there are any).

Although there are still some linguists – such as Bateni (1975), Majidi (1986) and Meshkotod Dini (1995) – who have remained loyal to the traditional (C)V(C)(C) system, the majority of the sources available to me have accepted the CV(C)(C) system. In addition to those mentioned earlier, a few of these are Towhidi (1974), Windfuhr (1979), and Haq Shenas (1996). My study is also based on the CV(C)(C) system.

The CV(C)(C) system implies the following characteristics for the Persian syllable structure:

(1) The first segment of any syllable is always a consonant.

(2) The nucleus of the syllable is always a vowel.

(3) Vowel clusters are not permitted.

(4) Consonant clusters are permitted only in the coda.

(5) The maximum number of consonants in syllable-internal clusters is two, but at syllable boundaries there may be a sequence of three consonants (i.e. CC-C).

(6) In any utterance there are as many syllables as there are vowels.

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[26] This has been taken directly from Najafi (1996: 65). In the original text, the examples are in Persian script. Najafi uses the symbols "V̌" for short vowel and "V̄" for long vowel. In Persian, /a, i, u/ are long and /ä, e, o/ are short.

(7) There is no ambiguity in identifying syllable boundaries. In any sequence the consonant immediately preceding a vowel begins a new syllable.

1.4.3. Phonotactics

The first extensive phonotactical study of Modern Persian was carried out by Krámský (1939). In his research, Krámský chose words as the unit of reference and studied the distribution of phonemes in relation to the beginning, middle and end of the word. Krámský's data was restricted to monosyllabic and disyllabic words, categorised etymologically into two groups: Persian words and Arabic loans. In 1948 he did a similar but more detailed study. This time his data included only monosyllabic words. Krámský's studies were based on statistical analysis.

Two other studies, on the distribution of phonemes in Modern Persian were carried out by Nye (1954) and Jazayery & Paper (1961). Both of these studies are very brief and limited mostly to the examination of the structure of consonant clusters.

Samareh's book, *The arrangement of segmental phonemes in Farsi* – published in 1977[27] – was a turning point in the study of the phonotactics of Modern Persian. In this study, Samareh extensively analysed both the structure of Persian syllables and the structure of Persian words. His research was based on the method of O'Connor & Trim (1973) and supported the CV(C)(C) syllable system and eight-phoneme vowel system (i.e. six simple vowels and two diphthongs). In 1985, Samareh published another book in Persian titled *Avashenasi-ye zaban-e Farsi*. This book includes among other things a revised version of his 1977 research. It deals mainly with the structure of monosyllables, and the structure of multi-syllabic words is not dealt with. In this book, Samareh has revised his view on the vowel inventory of Persian and rejected the existence of phonemic diphthongs.

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[27]   This research seems to be based on the unpublished dissertation of Samareh titled *The phonological structure of syllable and word in Tehrani Persian* (London University).

Another major investigation in the field of the phonotactics of Persian was done in 1986 by Majidi. Majidi's study was published in the book *Strukturelle Grammatik des Neupersischen (Farsi), I: Phonologie*. The main difference between this study and the study of Samareh (1977) is in the typology of syllables and in the inventory of vowel phonemes. Majidi's study is based on the six-pattern (C)V(C)(C) syllable system and six-phoneme (i.e. /ä, a, e, o, i, u/) vowel system. This difference in the selection of syllable and vowel typologies has resulted in diverging conclusions. In comparison to Samareh's studies, Majidi's research contains more statistics.

This present study partly corrects and to a greater extent completes the earlier scholarship on the phonotactics of Modern Persian.

1.5. Goal, method, data, and terminology of this study
1.5.1. Goal

The goal of this study is to characterise well-formed syllables in Modern Persian, i.e. showing what kinds of syllables are permitted in the language, and finding out what properties of the syllable are favoured in the language. I will test the hypothesis that sonority decreases towards syllable edges (in syllables with consonants at the margins): Can the hypothesis account for what is permitted in a syllable, or what is favoured?

The study also takes etymology into account. The purpose is to see what impact if any loanwords have on the properties of syllables in Modern Persian.

The study seeks answers to the following kinds of questions:

(1) What phonemes are permitted in different syllabic positions of different syllable types?
(2) What phonemes/phoneme classes are favoured in different positions of each syllable type?
(3) What restrictions if any are there on phoneme sequences in a syllable?
(4) What sequences (especially CC sequences) are preferred/not-preferred?

(5) Are the results (of what is permitted/favoured) in agreement with the hypothesis that sonority decreases towards the syllable edges?

(6) Are all nuclear vowels equally favoured in each syllable type? In case there are differences, are they connected with the degree of sonority of the vowel?

(7) How do syllables from words of Persian origin differ from those that only occur in words of foreign origin?

1.5.2. Method

The research method used in this study follows the general guidelines developed in earlier, mainly structuralist studies. The basic unit selected for this study is the syllable. The choice is very convenient for Persian, since the syllabification results in unambiguous divisions. Distributions of phonemes and phoneme classes are described for each slot of different syllable types. In addition to phonemes and phoneme classes, sequences of phonemes and phoneme classes are also studied. CC clusters are especially in focus.

Unlike previous studies, the present one aims at finding out not only what properties of a syllable are permitted, but also what properties are favoured. In addition, the etymological source of the syllable is taken into account. This means that several sets of data are needed for the analysis.

1.5.3. Data

This study is restricted to the investigation of the syllable internal phonotactics in Modern Persian. For this reason the first attempt was to establish a list of basic syllables of Modern Persian. Basic syllables are defined in this study as those syllables that act as the building blocks of Persian words.

The data used for extracting the basic syllables was a collection of 10175 words[28] (lexemes[29]), mostly selected from a widely-used Persian dictionary

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[28]   An alternative way to discover the basic syllables was to use transcriptions of running speech. In some languages such as Dutch (Schiller 1969: 42) there are syllables that are not permitted on the word level, but occur on the sentence level. In 1990, I examined and analysed transcriptions of some articles and news read on the Iranian radio and

Farhang-e Farsi-ye Mo'in (Mo'in 1992). Three other dictionaries, *Farhang-e Amid* (Amid 1984), *Farhang-e Farsi-ye emruz* (Sadri Afshar 1994) and *Farhang-e alefbayi-ghiyasi-ye zaban-e Farsi* (Moshiri 1995) were also consulted. All the dictionaries also give the pronunciation of each word. This data will be referred to hereafter as the Data of Words (DW).

Since the type of Persian studied in this research is restricted to the literary Tehrani dialect, I have excluded the following categories in selecting the material: slang words, obscene words, unusual pronunciations, learned scientific terminology and highly archaic words. However, wherever necessary, for example when discussing missing structures, I marginally and briefly deal with theses categories as well.

A major problem with Modern Persian is that many words have multiple pronunciations.[30] When a word has two or more equally common pronuncations, and should the difference in pronunciation result in exclusive structures, I have included all the variants in the data.[31] Otherwise I have chosen the variant my informants and I (also a Persian speaker) judged to be the most common one.

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television. Syllabification of these transcriptions consisting of about 9000 words, produced about 1800 basic syllables and did not introduce any syllables not listed in the inventory of the basic syllables in Appendix 5. There is no question that the sample of running speech I examined was not very large, but in my opinion it was large enough to show whether or not there are at least some structures which are exclusive to sentence level syllabification.

[29] Lexemes are defined here as "the units that are listed in the dictionaries as separate entries" (Crystal 1985).

[30] For example, see the following list of eight Persian words and how their pronunciations have been transcribed in different dictionaries. In this list, when a dictionary suggests more than one pronunciation for the same word, all variants are enclosed within {} signs. The words in question have been transcribed in this study as follows: /rešve/, /deräxšan/, /kelenǰar/, /sädme/, /nošxar/, /mohebbät/, /hädiyye/, /nemud/.
Moshiri (1995): {/rošve/, /rešve/}, {/doräxšan/, /däräxšan/, /deräxšan/}, /kälänǰar/, /sädäme/, /nošxar/, {/mähäbbät/, /mohäbbät/, /mohebbät/}, /hädye/, {/nomud/, /nemud/}.
Dehkhoda (1993): {/rošve/, /rešve/}, /doräxšan/, /kelenǰar/, /sädämä/, {/nošxar/, /nešxar/}, /mähäbbät/, {/hädye/, /hädyä/}, {/nomud/, /nemud/}.
Mo'in (1992): {/rošvä/, /rešvä/, /räšvä/}, {/doroxšan/, /doräxšan/, /däräxšan/}, /kelenǰar/, {/sädmä/, /sädme/}, /nošxar/, /mähäbbät/, {/hädye/, /hädiyyä/, /hädiyye/}, /nomud/.
Amid (1984): {/rošvä/, /rešvä/, /räšvä/}, /doräxšan/, /kälänǰar/, /sädmä/, /nešxar/, /mähäbbät/, /hädiyyä/, /nämud/.
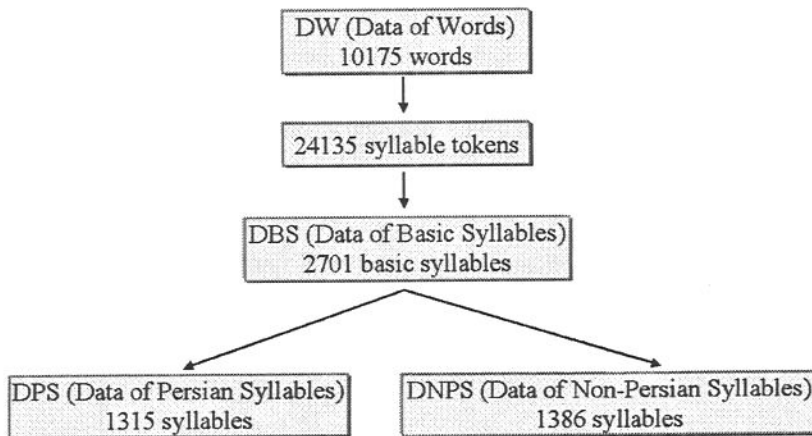Aryanpur-Kashani (1978): /rešve/, /däräxšan/, /kelenǰar/, /sädäme/, /nošxar/, /mohäbbät/, /hädye/, /nemud/.

[31] For example, /xebre/ and /xobre/ are two common variants of the same word, and difference in pronunciation yields two exclusive syllables /xeb/ and /xob/.

The pronunciation of all selected words were checked with five native speakers of Persian in Tehran in 1992 and 1996. The term *native speaker* is applied here to a person who was born in Tehran and in a Tehrani family and has an excellent command of the Tehrani dialect of Persian. All my informants were educated and two had academic degrees. The data were presented to the informants in two phases. In the first phase, I asked them to read the data from a manuscript written in unvocalised Persian script. As they were reading the list of words, I checked the phonemic transcription of the data I had prepared in advance. In the second phase, I presented the phonemic transcription to the informants for their examination and judgement. In this study, all words, syllables and segments will be presented in phonemic transcription unless otherwise specified.

The words in the DW were broken into syllables. The outcome was a list of 24135 syllables. Some of the syllables in this list have a frequency of nearly 600. For example, the frequency of /tä/ is 590; i.e. it occurs 590 times in the words of the DW. Syllabification of the DW yielded 2701 different syllables. In other words, the DW is the result of different combinations of these 2701 basic syllables. I will refer to this group of 2701 syllables as the Data of Basic Syllables (DBS).

This study approaches the phonotactics of Modern Persian in two stages. In the first stage, the etymology of the words is not taken into consideration and loanwords are treated together with etymologically Persian words. In the second stage, the impact of loanwords on the phonotactics of Modern Persian is examined. Due to this two-stage approach, two more data sets were created out of the DBS: the Data of (etymologically) Persian (basic) Syllables (DPS) and the Data of Non-Persian (basic) Syllables (DNPS). Those syllables that are found both in words of Persian origin and in words of foreign origin are all included in the DPS. It follows from this that while the DPS contains all (basic) syllables coming from words of Persian origin, the DNPS does not contain all basic syllables that are found in loanwords; the DNPS has only those basic syllables of the DBS that do not occur in etymologically Persian words. The DPS consists of 1315 syllables, 48.69% of the DBS, and the DNPS consists of 1386 syllables,

51.31% of the DBS. The following diagram illustrates the different kinds of data used in this study:

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            ┌──────────────────────┐
            │  DW (Data of Words)  │
            │     10175 words      │
            └──────────────────────┘
                       │
                       ▼
            ┌──────────────────────┐
            │ 24135 syllable tokens│
            └──────────────────────┘
                       │
                       ▼
         ┌─────────────────────────────┐
         │ DBS (Data of Basic Syllables)│
         │      2701 basic syllables    │
         └─────────────────────────────┘
              ╱                    ╲
             ▼                      ▼
┌──────────────────────────────┐  ┌──────────────────────────────────┐
│ DPS (Data of Persian Syllables)│  │ DNPS (Data of Non-Persian Syllables)│
│        1315 syllables          │  │           1386 syllables           │
└──────────────────────────────┘  └──────────────────────────────────┘
```

1.5.4. Terminolgy

In referring to phoneme classes, terms familiar from the articulatory descriptions will mainly be used in this study:

Manner classes: obstruents and sonorants, i.e. the two major classes of consonants

Manner subclasses: subclasses of obstruents and sonorants, i.e. stops, affricates, fricatives, nasals, liquids and glides

Labials: bilabials and labiodentals

Dentals: dentoalveolars and alveolars

Palatals: Alveopalatals and palatals

Place classes: Labials, dentals palatals, velars, uvulars and glottals

Non-continuants: stops and affricates

Continuants: fricatives and sonorants

There is a general agreement that the feature [-continuant] belongs to stops and affricates, and the feature [+continuant] belongs to fricatives, liquids and glides.

The problematic class is nasals; Trubetzkoy (1969: 141) considers them to be continuant, and so do O'Connor (1973: 206) and Jakobson (Jakobson and Waugh 1990: 260). Chomsky and Halle (1969: 176-177), on the other hand, assign the feature [-continuant] to nasals. In this study, nasals are interpreted as belonging to the class of continunats.

Back area consonants: velars, uvulars and glottals. This class does not correpond to to the feature [+back], since glottals are [-back].

The structure of the study is as follows: Chapters 2 and 3 give a general background of the data. Chapter 2 describes properties of the Data of Words (DW): word structure, etymological sources, and consonant and vowel frequencies in the data. Chapter 3 characterises the Data of Basic Syllables (DBS), i.e. the distribution of different syllable types in the data, etymological sources of the syllables, and consonant and vowel frequencies in the DBS. Chapters 4 to 6 form the core of the study: they present analyses of properties of different syllable types. Chapter 4 deals with CV and CVC syllables, both in the the DBS, and in the etymological subdata, the DPS and the DNPS. Chapter 5 characterises CVCC syllables in the DBS, and Chapter 6 describes them from the point of view of etymology, i.e. in the DPS and in the DNPS. Finally, Chapter 7 gives a short summary of the study.