Chapter 3

Onset clusters, syllable structure and syllabification in Maltese

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This chapter aims to describe syllable structure and the phonotactic constraints on onset consonants in Standard Maltese. The current work is based on the phonetic and phonological description of Maltese in Azzopardi (1981) and Borg & Azzopardi-Alexander (1997). The phonological account provided here, however, is grounded in an Onset-Rhyme model. Furthermore, the phonotactics of Maltese are described in terms of sonority. After establishing the nature of onset consonants in Maltese, we address the process of syllabification in Maltese.

1 Maltese syllable structure

Before describing the possible syllable structures in Maltese, it is important to highlight that Maltese monosyllables are restricted by complementary quantity. This means that in monosyllabic words (cf. Table 1), short vowels are either followed by a geminate (G) or by a consonant cluster (CC), and long vowels are followed by a single consonant but never by a geminate (Azzopardi-Alexander 2002). This does not mean that open syllables in Maltese do not occur; however, they are not restricted by quantity.

Therefore, in Maltese the syllable types V:G and V:CC do not occur due to this complimentary quantity restriction, and as a result are not found in syllable structures with added onsets or codas.

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Table 1: Complementary quantity in Maltese[1]

CVG	[hɐpp]	*ħabb*	'he loved'
CVCC	[tɐlp]	*talb*	'prayer'
CV:C	[kɐ:p]	*kap*	'boss'

Azzopardi (1981) and Borg & Azzopardi-Alexander (1997) present the possible syllable types in Maltese. They argue that the minimal syllable requirement is a vowel. The maximum number of onset consonants is three and the maximum number of coda consonants is two. Thus, a maximal Maltese syllable would have the shape (C)(C)(C)V(C)(C).

A clearer picture of the possible syllable structure of Maltese is presented in (Camilleri 2014: 48), who discusses syllable structures that occur as monosyllables and within word forms. We extend Camilleri (2014)'s list of possible syllable structures, adding additional structures to that list, in order to provide an exhaustive list (cf. Table 2) of the possible syllable structures (both as monosyllables and within word forms). Therefore, the possible syllable structures listed in Table 2 are based on Azzopardi (1981), Borg & Azzopardi-Alexander (1997) and Camilleri (2014). What is presented in this chapter is a first attempt at fully capturing the possible syllabic structures (both onsets and codas) in Maltese (some of this work appears in Galea 2016). However, our focus in this paper is on onsets, and the description in Table 2 is split into four categories: 1) vowel-initial syllable structures: *V-initial*, 2) one-consonant onset syllable structures: *C-initial*, 3) two consonant onset syllable structures: *CC-initial* and 4) three consonant onset syllable structures: *CCC-initial* to show the syllabic nature of onsets in Maltese. A — in Table 2 refers to forms that do not occur as either monosyllables or within-word forms.

[1]As noted by a reviewer, some non-standard varieties might have different forms. Furthermore, traditionally the digraph 'għ' in Maltese is linked to vowel lengthening (as discussed in Azzopardi 1981). However, a thorough phonetic/phonological study on this has not been carried out.

Table 2: Possible syllable types and onset distribution in Maltese

Initial	Syllable type	Monosyllable	Within-word forms
V	V[2]	[ʊ] *hu* 'he'	[ʊ.hut] *uħud* 'some'
	VG	[ɔmm] *omm* 'mother'	—
	VCC	[ɛlf] *elf* 'thousand'	—
	VCCC[3]	[ɪntʃ] *int=x* you.2sg/2pl=neg 'aren't you'	—
	V:C	[ɐ:f] *af* know.3sg 'know'	[ɐ:f.sɐ] *għafsa* 'a squeeze'
	V: (e.g., V:CVC)	—	[ɛ:.mɛs] *għemeż* wink.3sgm.perf 'he winked'
	VC (e.g., VC.CVC)	—	[ɔr.bɔt] *orbot* 'tie (imp.)'

[2]This category (V) is problematic as it is not clear whether such a monosyllable exists as an autonomous stress bearing unit or not. Furthermore, the language does not provide many examples of this type, which might add to its questionable status.

[3]There is a lack of morpheme-internal triconsonantal codas and the cluster spans two morphemes.

C	CV	[lɛ] *le* 'no'	[lɛ.fɐʔ] *lefaq* 'he sobbed'
	CV:	[dʒɪː] *ġie* 'he came'	[dʒɪː.li] *ġieli* 'sometimes'
	CVW	[rɐw][4] *raw* 'they saw'	[rɐw.kɔm] *rawkom* 'they saw you'
	CVC	—	[hɐz.bɛt] *ħasbet* 'she thought'
	CV:C	[tɐːf] *taf* 'she knows'	[tɐːf.nɐ] *tafna* 'she knows us'
	CVG	[hɐpp] *ħabb* 'he loved'	[tɪn.hɐpp] *tinħabb* 'to be loved'
	CVGC	[zɐmmʃ] *żammx* 'he didn't hold'	[ɪn.zɐmmʃ] *inżammx* 'it wasn't held'
	CVCC	[bɐrt] *bard* 'cold'	[kɐz.bɐrt] *kasbart* 'I disgraced'
	CVCCC	[mɔrtʃ] *mortx* 'didn't go'	—

[4]There is disagreement in the literature on whether this vowel is a long vowel or not (see Borg 1986:231; and Camilleri 2014:48). However, neither of these studies investigated this issue empirically and we suggest that this would be the best way of resolving the issue.

CC	CCV	[blɐ] *bla* 'without'	[stɐ.hɐ] *staħa* 'he was shy'
	CCV:	[kjuː] *kju* 'queue'	[kpɪː.pɛl] *kpiepel* 'hats'
	CCVW	[tfɛw] *tfew* 'they switched sth off'	[tfɛw.kɔm] *tfewkom* 'they outshone you'
	CCVC	—	[ftɐh.tʊ] *ftaħtu* 'I opened it'
	CCV:C	[frɐːk] *frak* 'crumbs'	[kniːs.jɐ] *knisja* 'church'
	CCVG	[frɔtt] *frott* 'fruit'	[ʊ.zuː.frʊtt] *użufrutt* 'usufruct'
	CCVGʃ[5]	[ʔbɐttʃ] *qbatx* 'didn't catch'	[ɪn.ʔbɐttʃ] *inqbadtx* 'I didn't get caught'
	CCVCC	[frɪsk] *frisk* 'fresh'	—
	CCVCCC	[hsɪltʃ] *ħsiltx* 'didn't wash'	[ɪn.hsɪltʃ] *inħsiltx* 'I didn't shower'

[5] This syllable structure can only occur through morphological inflection, through the addition of the negative suffix /-ʃ/.

CCC	CCCV:	[strɔː] *straw* 'straw'	[zbrɐː.nɐ] *żbrana* 'he exploded'
	CCCVW	[ʃtrɐw] *xtraw* 'they bought'	[ʃtrɐw.nɐ] *xtrawna* 'they bought us'
	CCCVC	—	[strɐm.bɐ] *stramba* 'odd (fem.)'
	CCCV:C	[sptɐːr] *sptar* 'hospital'	—
	CCCVCC	[strɐmp] *stramb* 'odd (m)'	—
	CCCVG	[ftrɐkk] *f'trakk* 'in a truck'	—

Focusing on the structures CVW, CCVW and CCCVW, Camilleri (2014) claims that the vowel before syllable- or word-final glides (/w, j/) is always a short vowel. Therefore, following Camilleri's (2014) description, this creates the possible syllable structures CVC, CCVC, CCCVC, where the coda consonant is always a glide. We do not fully commit to Camilleri's (2014) claim because sequences such as [ɐw], [ɛw], [ɐj] and so on are what Azzopardi (1981) and Borg & Azzopardi-Alexander (1997) consider to be diphthongs. Therefore, the rhyme of the syllable is a vowel plus a transition to another vowel or a glide (cf. Azzopardi 1981). Bearing this in mind, it is not clear whether the vowel before is short or not. Since there are no empirical studies that show the phonetic realizations of diphthongs in Maltese, we consider these structures to be of the type C(C)(C)VW, where W stands for the glides /w, j/. A glide is part of the nucleus, because if it were a separate consonant we would predict vowel lengthening since a short vowel plus a coda consonant would violate the bimoraic minimum on syllable nuclei (e.g., compare [tɐw] *taw* 'they gave' and [rɐːt] *rat* 'she saw').

The list of possible syllable structures presented in Table 2 differ from those proposed by Camilleri (2014). Camilleri (2014) lists the syllable structure CCV: as occurring only as a within-word form but not as a monosyllable. Camilleri (2014) illustrated this type through the word /kniːsja/ *knisja* 'church'. We disagree with this description as following the syllabification process in Maltese (which is discussed in §2), the /s/ serves as a coda to the previous syllable (and not as an onset to the following syllable); therefore, the syllable structure of the word /kniːsja/ *knisja* is not CCV:.CCV but CCV:C.CV. In the list in Table 2, we provide the example /kjuː/ *kju* 'queue' (another possible example is /bluː/ *blu* 'blue'), which show that that the structure CCV: can also occur as a monosyllable.[6]

Two structures are not reported by Camilleri (2014). First, the structure CCCV: in /strɔː/ *straw* 'straw' occurs both as a monosyllable and within words. Secondly, a long vowel, V:, can occur as a syllable within words, e.g., /ɛː/ in /**ɛ**ː.mɛs/ *għemeż* 'he winked' or /ɐː/ in /**ɐ**ː.fɐs/ *ġħafas* 'he pressed'. In (C)CVGC, the C following the geminate is restricted to the occurrence of the morpheme /-ʃ/ used for negation as in the examples: [ɪn.**zɐmmʃ**] *inżammx* 'it was not held' and [ɪn.**ʔbɐttʃ**] *inqbadtx* 'I didn't get caught', or /-s, -z/ as a suffix for English-origin plurals; e.g., /klɐpps/ *clubs* 'clubs'. Furthermore, the syllable type C(C)VCCC as in the examples (from Table 2) [mɔrtʃ] *mortx* 'I didn't go' and [hsɪltʃ] *ħsiltx* 'I didn't wash' (and other words which include these syllables) are limited to the 1st person and 2nd person negative inflected forms.

In the following subsections, we describe the phonotactic constraints of each syllable structure type from Table 2 in detail. Specifically, we address both phonetic and phonological issues of each syllable structure type. The description of the permissible onset consonants is achieved through the principles of sonority (for codas cf. Galea 2016). In this work, we adopt the sonority scale below. Furthermore, we also adopt Selkirk's Sonority Sequencing Principle (Selkirk 1984), which requires a sonority rise between a left-margin constituent and the syllable peak:

(1) Vowels > glides > sonorants > obstruents
High Sonority Low Sonority

1.1 The nucleus

All vowels in Maltese can serve as a syllable nucleus. As a matter of fact, the language allows vowels on their own to occur as a permissible syllable. This is

[6] Nonetheless, these are open empirical questions, which should be investigated in production studies.

restricted to a few words, typically function words and often unstressed, such as /ɪ/ *hi* 'she', /ʊ/ *hu* 'he' or *u* 'and', some exclamations such as /ɔː/ 'oh', but also, less frequently, content words such as /ɐː/ 'confusion'.

1.2 Vowel-initial syllable structures

It is debatable whether Maltese allows onsetless syllables. The phonetic realization of onsetless syllables shows that vowels are variably preceded by an epenthetic glottal stop, which constitutes a syllable onset; e.g., /ʊ/ → [ʔʊ] *hu* 'he' (Azzopardi 1981). As a matter of fact, Borg & Azzopardi-Alexander (1997) claim that this insertion is more likely to happen in utterance-initial or in post-pause position.[7] This might suggest that the preferred syllable structure in Maltese requires onsets (i.e., .CV…), and this type of epenthesis occurs in spoken Arabic dialects and dialects of English and German. To illustrate, syllables in Arabic always require an onset. If syllables lack an onset, a glottal stop is inserted (cf. Standard Arabic, Egyptian Arabic: Gadoua (2000); Cairene Arabic: Wiltshire (1998); Youssef (2013)). The preceding context triggers the insertion of a glottal stop; Wiltshire (1998) argued that when the definite article is in phrase-initial position an epenthetic glottal stop is always inserted, as in [ʔil.mu.dar.ris] 'the teacher'. This observation is also put forward by Youssef (2013), who claimed that in Cairene Arabic, the definite article /il/ is always preceded by an epenthetic glottal stop: [ʔil].

Historically, Maltese had a voiced pharyngeal approximant [ʕ], which is no longer present in current Maltese though it is represented in the orthography by the digraph <għ>. Borg (1997) and Brame (1972) argue that vowels adjacent to orthographic <għ> are lengthened, whereas Puech (1979) argues that this vowel duration is context-dependent. Hume et al. (2009) investigated this observation by recording two native speakers of Maltese. They investigated whether the vowels adjacent to <għ> are lengthened in a variety of positions within the word. Focusing on absolute phrase-initial position, Hume et al. (2009) argued that there is increased vowel duration in the <għ> context in monosyllabic words; e.g., in a minimal pair such as [ɐːtt] *għadd* 'he counted' and [ɐtt] *att* 'act', they showed that the duration of the vowel /ɐ/ is longer in the <għ> context. Nonetheless, even though they had a number of vowel-initial syllables in their corpus, Hume et al. (2009) did not report whether there were any glottal stop insertions before the vowel.

[7] Galea (2016) provides similar results to this claim. Some speakers seem to insert a glottal stop before the epenthetic vowel before word-initial geminates. This might suggest that, at least for some speakers, glottal stops before vowels are required by their phonology.

To sum up, potentially underlyingly vowel-initial syllables in Maltese might actually be phonetically realized as .CV…, where the C is an epenthetic glottal stop. If this is true, there are no truly vowel-initial syllables in the language, because the epenthetic glottal stop serves as an onset to a vowel-initial syllable. Words that have orthographic <għ> or <h> in absolute initial position tend to have longer adjacent vowels. However, only the durations of vowels adjacent to <għ> have been investigated empirically (Hume et al. 2009). Furthermore, <għ>-initial words would be preceded by a glottal stop. Related evidence to this can be found in orthography where <għ>-initial words are occasionally misspelled by literate native speakers with the letter <q> (the grapheme used to represent glottal stop); e.g., <qandi> instead of <għandi> 'I have'. This evidence shows that some speakers consider that the glottal stop is part of the phonology of these words. However, production studies need to be carried out to fully understand this phenomenon.

1.3 Permissible onsets in Maltese

Almost all consonants in the inventory of Maltese constitute permissible single onsets; examples are listed in Table 3 below. The status of the phone /ʒ/ in Maltese is unclear (cf. Borg & Azzopardi-Alexander 1997). It occurs in some loan words such as [tɛlɛvɪʒɪn] *televixin* 'television', where the voiced post-alveolar fricative constitutes an onset to the final syllable. Furthermore, it can occur as part of onset clusters such as [ʒbiːɐ][8] *xbiha* 'image'; however, there are no monosyllabic words which have [ʒ] as a single onset consonant. In all of the examples presented in Table 3, there are no sonority violations in the onset consonant. The structure conforms to the SSP, since a single consonant is always less sonorous than a vowel as the nucleus.

1.4 Permissible onset clusters in Maltese

It is generally claimed that the larger the distance in sonority between the first consonant (C_1) and the second consonant (C_2) in a consonant cluster, the more well-formed the onset cluster is (Topintzi 2011). Nonetheless, clusters having the same or similar sonority are allowed to occur in sequence in a number of languages, such as Russian and Bulgarian. This is referred to as the *Minimum Sonority Distance* principle (cf. Selkirk 1984; Levin 1985; Parker 2011). Maltese is one

[8] This [ʒ] is only voiced because it is C_1 in a CC onset in which C_2 is voiced, thus triggering regressive voicing assimilation, which operates in Maltese onset clusters and is discussed later on this section.

Table 3: Simple onsets in Maltese

Stops	[pɐːɪ] *par* 'pair' [bɐːɪ] *bar* 'bar' [tɐːɪ] *tar* 'he flew' [dɐːɪ] *dar/dahar* 'back/house' [kɐːp] *kap* 'head of an institution' [gɔst] *gost* 'fun' [ʔɐːm] *qam* 'he woke up'
Fricatives	[fɐːɪ] *far* 'it overflowed' [vɐːɪɐ] *vara* 'statue' [sɐːɪ] *sar* 'it became' [zɐːɪ] *żar* 'he visited' [ʃɐːɪ] *xahar/xagħar* 'month/hair' [hɐll] *ħall* 'vinegar/ he undid (a knot)'
Affricates	[tʃɐːɪ] *ċar* 'clear' [dʒɐːɪ] *ġar* 'neighbour' [tsɔkk] *zokk* 'branch' [dzɔːnɐ] *żona* 'zone'[9]
Nasals	[mɐːɪ] *mar* 'he went' [nɐːɪ] *nar* 'fire'
Glides	[wɐʔt] *waqt* 'during' [juːm] *jum* 'day'
Liquids	[lɐːt] *lat* 'point of view' [rɐːt] *rat* 'she saw'

of the languages that allows clusters with minimum sonority distance. To compare, Spanish, for example, only allows onset clusters which are made up of an obstruent and liquid; e.g., /kr/ in /krus/ 'cross' (Baertsch 2002), which means that onset clusters in Spanish have a larger distance in sonority between C_1 (e.g., /k/) and C_2 (e.g., /r/). On the other hand, languages such as Russian, Bulgarian and Leti allow onset clusters containing consonants which are closer on the sonority scale; e.g., /kn/ in Russian /kniga/ 'book'. However, Parker (2011: 1168) claims that

[9]For some speakers this is pronounced as [zɔːnɐ].

"if a language permits clusters with a lower sonority distance, it allows clusters of all higher distances as well" but not the other way around, which is the case in Maltese. Clusters that have minimum sonority distance give rise to plateaus. Sonority plateaus arise when there is no difference in sonority between the members of a consonant cluster (such as in Maltese /tp/ in /tpɛjjɛp/ 'you/she smokes' or /sf/ in /sfɔrts/ 'effort'). The SSP states that there must be one peak from the onset to the syllable nucleus; thus, plateaus in the onset violate the SSP. Blevins (1995), following Jespersen (1904)'s version of the SSP, accounts for such plateaus, whereas other versions of the SSP do not (e.g. Selkirk 1984; Clements 1990; Zec 2007). A syllable with an onset cluster such as /kl/ in /klɪːm/ *kliem* 'kliem' or /pr/ in /prɛtsts/ *prezz* 'price' has a higher sonority distance, and this leads to a rising sonority profile from the onset to the syllable nucleus. In comparison, consonant clusters such /kt/ in /ktɪːb/ *ktieb* 'book' or /dv/ in /dvɐljɐ/ *dvalja* 'table cloth' lead to a sonority plateau and, thus, a possible violation of the SSP.

In addition to allowing onset consonant clusters with very 'flat sonority' (Zec 2007), Maltese also places a constraint on word-initial tautosyllabic consonant clusters: they are restricted by a voicing assimilation rule which operates regressively. Therefore, consonant clusters are both voiced or both voiceless: e.g., [bdɛw] *bdew* 'we started'; [pkɪːt] *bkiet* 'she cried'.

To give an example of the range of possible clusters from low sonority distance to high sonority distance, we show the spectrum of possible consonant clusters beginning with /p/ in Table 4. The permissible clusters start from those that have a minimum sonority distance (e.g., /pt/, /pk/), which lead to a sonority plateau, which are followed by clusters that have a higher sonority distance (e.g., /pr/ and /pj/).

(2) lists some examples of minimum distance sonority clusters of voiced consonant clusters:

(2) Voiced consonant clusters
   a. /bd/ in /bdiːl/ bdil 'change'
   b. /dg/ in /dgɔrr/ tgorr 'you complain'
   c. /zb/ in /zbiːp/ żbib 'raisins'

In the case of higher sonority distance onset clusters, Maltese allows: Obstruent + Nasal, Obstruent + Liquid, Obstruent + Glide, as in (3).

Table 4: Permissible /p/-initial clusters

MSD	Cluster	Example	Sonority
Low	/pt/	[ptɐː.lɐ] btala ‘holiday’	
↓	/pk/	[pkɛw] bkew ‘they cried’	**Plateau**
	/pʔ/	[pʔɐjt] bqajt ‘I stayed’	
	/ptʃ/	[ptʃɛj.jɛtʃ] bċejjeċ ‘pieces’	
	/pts/	[ptsɪː.tsɛn] bżieżen ‘bread rolls’	
	/ps/	[psɐrt] bsart ‘I guessed’	
	/pf/[10]	[pfɔr.mɐ] b’forma ‘with a shape’	
	/pʃ/	[pʃɐː.rɐ] bxara ‘announcement’	
	/ph/	[phɐːl] bħal ‘like’	
	/pn/	[pnɪː.tsɛl] pniezel ‘brushes’	
	/pl/	[plɐtː] platt ‘plate’	
	/pr/	[prɛtsː] prezz ‘price’	
	/pw/	[pwɪː.nɪ] pwieni ‘pains’	**Increase**
High	/pj/	[pjɐːn] pjan ‘plan’	

(3) Examples of higher sonority distance clusters

a. Obstruent + Nasal
/tn/ in /tnɛjn/ tnejn ‘two’
/zm/ in /zmɪːn/ żmien ‘time’

b. Obstruent + Liquid
/dl/ in /dlɐːm/ dlam ‘darkness’
/fr/ in /frɐːr/ Frar ‘February’

c. Obstruent + Glide
/ʔw/ in /ʔwɪːl/ qwiel ‘idioms’
/vj/ in /vjɐtʃtʃ/ vjaġġ ‘journey’

The voicing assimilation rule is not strictly respected in clusters beginning with /ʔ/ and /h/. When these consonants occur as C_1 in a CC consonant cluster, voicing assimilation is violated when C_2 is a voiced obstruent e.g., /ʔb/ in /ʔbiːl/ *qbil* ‘agreement’ and /hd/ in /hduːt/ *ħdud* ‘Sundays’. Even though the voicing

[10] Cluster /pf/ appears only in the case of the preposition *b’* before /f/. As one reviewer noted, this type of sonority profile is limited to morphologically complex examples (e.g., /fp/ in /fprɔtʃɛss/ *f’proċess* ‘in process’

harmony is violated, the SSP is not; instead, this leads to a sonority plateau. In the opposite case, when a voiced obstruent is in C_1 position and /ʔ/or /h/ is in C_2 (e.g., /bʔ/ in /bʔɐjt/ *bqajt* 'I stayed', and /dh/ in /dhuːl/ *dħul* 'entrances'), such clusters lead to a sonority reversal. Borg & Azzopardi-Alexander (1997) claim that the frequency of consonant cluster onsets with /ʔ/ and /h/ + voiced obstruent (e.g., [hd]) is lower than that of CC onsets of /ʔ/ and /h/ + voiceless obstruent (e.g., [ht]). Furthermore, /ʔ/ and /h/ also cluster with consonants further up in the sonority scale as in (4):

(4) Consonant clusters with /ʔ/ and /h/ as C_1

a. /ʔl/ in /ʔluːp/ qlub 'hearts'
b. /ʔr/ in /ʔrɐːr/ qrar 'confession'
c. /hm/ in /hmɐːr/ ħmar 'donkey'
d. /hl/ in /hlɐːs/ ħlas 'payment'

1.5 Sibilant onset clusters

Maltese allows sibilant-initial onset clusters. To start with, Maltese permits sibilant-initial clusters which have a high sonority distance and do not violate the SSP as in (5).

(5) Sibilant onset clusters: high sonority distance

a. /sr/ in /srɪːp/ *sriep* 'snakes'
b. /zr/ in /zrɐːr/ *żrar* 'coarse aggregate used in concrete'
c. /ʃm/ in /ʃmuːn/ *Xmun* 'Simon'
d. /ʃl/ in /ʃlɔkk/ *Xlokk* 'south east'
e. /zm/ in /zmɛrtʃ/ *żmerċ* 'awry'

In sibilant obstruent clusters, the voicing assimilation rule still applies in sibilant clusters as in (6).

(6) Sibilant onset clusters: Voicing assimilation

a. /sk/ in /skuːr/ skur 'dark'
b. /sp/ in /spɪss/ spiss 'often'
c. /ʃt/ in /ʃtɐːʔ/ xtaq 'he wished'
d. /ʃk/ in /ʃkɪːl/ xkiel 'obstacle'
e. /zb/ in /zbɐll/ żball 'mistake'
f. /zv/ in /zvɔːk/ zvog 'vent'

Clusters such as /sk sp st zb/ in (6), just like in English and Italian, pose a challenge to the Sonority Sequencing Principle since the sibilant is more sonorous than the stop (in the first five examples in (6)) and leads to a sonority plateau in /zv/.

The syllabification of sibilant initial clusters has been a long-standing debate in phonology. Numerous approaches have been proposed: approaches which span from the strictly phonological, such as Kaye (1992), to more experimental approaches such as Browman & Goldstein (1992). Experimental evidence suggests that there is not a universal solution to syllabification: in some languages, like English (Marin & Pouplier 2010), sibilant clusters pattern like non-sibilant clusters and are considered to be tautosyllabic, but in other cases such as Italian, sibilant-obstruent clusters, unlike obstruent-liquid clusters, are heterosyllabic (Hermes et al. 2013). In languages such as Moroccan Arabic, Tashlhiyt Berber and possibly Maltese, sibilant-initial clusters and obstruent-initial clusters are heterosyllabic (see Hermes et al. 2014: for a preliminary articulatory study).

1.6 Sonorant-initial clusters

Maltese has consonantal sequences that have a sonorant (/l m n r/) as C_1. Maltese has combinations of sonorant + stop (e.g., /lp/, /md/, /nt/, /rk/), sonorant + fricative (e.g., /ls/, /ms/, /nz/, /rv/), sonorant + glottal (e.g., /mʔ/ and /nh/) sequences. However, such sequences violate the SSP, as C_1 is more sonorous than C_2. Also, such clusters are examples of sonority reversals, where C_1 is more sonorant than C_2. In order to avoid this sonority reversal one of two strategies can be employed in Maltese. First, Azzopardi (1981) proposes that the realization of sonorants as C_1 in a consonant sequence could be syllabic. Thus, /mʔɐːr/ surfaces as [m̩ .ʔɐːr] *mqar* 'at least'. This realization does not violate the SSP because a syllabic consonant constitutes its own syllable nucleus. The other strategy is to insert a vocalic element of [ɪ]-like quality before the sonorant consonant: [ɪm.ʔɐːr]. In this case, the vowel [ɪ] serves as a syllable nucleus, which is followed by the sonorant [m], which serves as coda to the first syllable. In addition, it is possible for a prothetic glottal stop to be inserted before the vocalic element. If this glottal stop were represented in the phonological structure, then this would constitute a syllable onset. More examples of sonorant-initial clusters are presented in (7):

(7) Realization of sonorant-initial clusters

a. /lp/ → [ɪl.puːp] or [ʔɪl.puːp] or [l̩.puːp] lpup 'wolves'

b. /md/ → [ɪm.diː.nɐ] or [ʔɪm.diː.nɐ] or [m̩.diː.nɐ] Mdina 'Mdina (name of town)'

c. /nz/ → [ɪm.ziːt] or [ʔɪm.ziːt] or [n̩.ziːt] nżied 'I add'
d. /rv/ → [ɪr.vɛll] or [ʔɪr.vɛll] or [r̩.vɛll] rvell 'rebellion'
e. /mh/ → [ɪm.hɐːr] or [ʔɪm.hɐːr] or [m̩.hɐːr] mħar 'clams'

Regardless of which strategy is employed, sonorant-initial clusters in Maltese are never tautosyllabic, but rather are always heterosyllabic.

1.7 CCC-initial clusters

As shown in Table 2, Maltese also allows for tri-consonantal word-initial clusters (abbreviated to CCC-initial). Borg & Azzopardi-Alexander (1997) show that the premitted combinations of consnants are very restricted. C_1 is usually a fricative (/s, ʃ, z/) or a bilabial stop (i.e., /p, b/). C_2 can be either an oral stop (i.e., /p, b, t, d, k, g/) or the fricative /f/. C_3 tends to be occupied by a sonorant but can be filled by any other consonants. It is important to note that voicing assimilation still applies in CCC-initial clusters. Furthermore, the prefixes /b-, p-/ 'with', /ʃ-/ 'what' and /f-/ 'in' can contribute to the creation of CCC-initial onsets. In Table 2, we provide the example [ftrɐkk] *f'trakk* 'in a truck', where the first consonant [f] is a prefix, leading to the triconsonantal cluster [.ftr…]. Additional examples of triconsonantal clusters in Maltese are provided in (8).

(8) CCC-initial

a. [stʔɐrr] stqarr 'he confessed'
b. [zbrɔffɐ] żbroffa 'he exploded'
c. [sptɐːr] sptar 'hospital'

2 Syllabification in Maltese

According to Borg & Azzopardi-Alexander (1997), polysyllabic words which have one consonant in medial position, such as CVCVC, are syllabified as CV.CVC, where the medial consonant constitutes a syllable onset to the following syllable, as in (9). This follows the Maximum Onset Principle (MOP) that a consonant flanked between two vowels is more likely to syllabify as an onset rather than a coda (cf. Kahn 1976).

(9) Syllable division of one medial consonant

a. [kɪ.sɛr] kiser 'he broke'
b. [mɪː.tʊ] mietu 'they died'

c. [lɐː.pɛs] lapes ‘pencil’
d. [tɪ.fɛl] tifel ‘a boy’

In polysyllabic words with structures like CVCCV or CVCCVC, medial consonant sequences are not treated as consonant clusters as they tend to be syllabified as the coda to the preceding syllable and the onset of the following syllable (cf. Azzopardi 1981). Therefore, the medial cluster in a CVCCV word split across the two syllables (CVC.CV); see (10) for examples.

(10) Syllable division of medial consonant sequences

a. [hɔl.mɐ] ħolma ‘dream’
b. [tɐh.fɛr] taħfer ‘forgiveness’
c. [ʃɔr.tɐ] xorta ‘sameness’
d. [tɔʔ.bɐ] toqba ‘hole’

The same syllable division applies to word-medial geminates as shown in (11).

(11) Syllable division of word-medial geminates

a. [hɐf.fɛr] ħaffer ‘he dug’
b. [rɐt.tɐp] rattab ‘he softened’
c. [tɛl.lɛf] tellef ‘he disrupted’
d. [ʔɐtʃ.tʃɐt] qaċċat ‘he removed’

Word-initial geminates occur due to morphophonological processes; however, they are disallowed phonologically. Word-initial geminates tend to be preceded by an epenthetic vowel, which in Maltese is a vowel of [ɪ]-like quality (see Galea 2016 for results on the production of the epenthetic vowel in different conditions across a number of speakers). For this reason, we assume that word-initial geminates in Maltese, like word-medial geminates, are ambisyllabic, where the first part of the geminate serves as a coda to the previous syllable and the second part of the geminate serves as an onset to the following syllable. Therefore, underlying word-initial geminates surface as word-medial geminates and are syllabified in the same way as word-medial geminates; see (12).

(12) Syllable division for word-initial geminates

a. /ppɐkkja/ → [ɪp.pɐk.kjɐ] ippakkja ‘he packed’
b. /ddɛffɛs/ → [ɪd.dɛf.fɛs] iddeffes ‘he poked his nose in s.o. else’s affairs’
c. /ssɛbbɐh/ → [ɪs.sɛb.bɐh] issebbaħ ‘he was beautified’

We argue that vowel epenthesis before word-initial geminates allows the syllabification of stray consonants (Itô 1986; 1989).

In the case of three-consonant sequences in word-medial position, Azzopardi (1981) proposed that the preferred syllabification of such sequences is as a consonant syllabified as a coda to the preceding syllable followed by a two-consonant onset cluster to the following syllable, as in (13).

(13) Syllabification of medial clusters

a. [mɐ**h.fr**ɐ] maħfra 'forgiveness'

b. [mɪ.nɪ**s.tr**ʊ] ministru 'minister'

It is also possible for such clusters to be syllabified in such a way that the first two consonants constitute a consonant cluster in coda position, and the third consonant constitutes a simple onset in coda position, as in (14).[11]

(14) Syllabification of medial clusters

a. [jɐ**ʔs.m**ʊ] jaqsmu 'they divide/share'

b. [hlɪ**st.k**ɔm] ħlistkom 'I freed you (pl.)'

There might be a correlation between syllable boundary and morpheme boundary in examples like [hlɪst.kɔm] *ħlistkom* 'I freed you (pl.)', where the coda consonant cluster [st] belongs to the verb and the initial [k] is part of the clitic. Yet, this is not the case in [jɐʔs.mʊ][12] *jaqsmu* 'they divide/share', where the suffix -ʊ is not placed in a syllable of it own. It is possible that in cases where the morpheme has a CVC structure (such as /**k**ɔm/ 'you (pl.)', such morphemes could constitute separate syllables. This suggests that morpheme boundaries are respected more than syllable boundaries, and as a result, this would lead to a division of a sequence of three consonants to CC.C.

2.1 Syllabification of sonorant-initial clusters and word-initial geminates

As previously described, sonorant-initial clusters and word-initial geminates in Maltese trigger vowel epenthesis in syllable-initial position (Azzopardi 1981; Borg & Azzopardi-Alexander 1997), as in (15).

[11] We acknowledge that this is highly speculative and the implications of our intuitions need to be emperically investigated.

[12] A counterexample of this is the 3F clitic [ɐ], as in [jɐʔ.sɐm.ɐ] *jaqsamha* 'he breaks her', where the morpheme constitutes a syllable on its own.

(15) Insertion before sonorant-initial clusters and word-initial geminates

a. /mhɐːr/ → [ɪmhɐːr] imħar 'clams'

b. /ʃʃɛjjɛr/ → [ɪʃʃɛjjɛr] ixxejjer 'you/she wave(s)'

Here, we discuss the role of the epenthetic vowel in the syllabification of sonorant-initial clusters and word-initial geminates. There seems to be a cross-linguistic consensus on the function of epenthetic vowels: they serve to repair input forms which do not meet a language's structural requirements (Hall 2011). Hall (2011) describes three ways in which epenthetic vowels surface. First, following Itô (1986; 1989) epenthesis allows the syllabification of stray consonants. Second, following Broselow (1982), epenthesis is triggered by a particular sequence of consonants. Finally, following Côté (2000), epenthesis is triggered by the need to make consonants perceptible. The case of epenthesis in word-initial position in Maltese falls into all three categories. Here, we describe how the epenthetic vowel in Maltese syllabifies stray consonants.

First, the location of the epenthetic vowel before sonorant-initial and word-initial geminates in Maltese is fixed: the epenthetic vowel always precedes a sonorant–initial consonant cluster (e.g., /nt/, /lt/, /ms/)[13] or word-initial geminate (e.g., /dd/, /vv/, /ss/). As the examples in Table 5 show, the epenthetic vowel is fixed both in position and also in quality as it always surfaces as a vowel of /ɪ/-like quality.

Table 5: Epenthetic vowel before sonorant-initial consonant clusters and word-initial geminates

Sonorant initial consonant clusters			**Word-initial geminates**		
/**nf**ɐʔt/→[ɪ**n.f**ɐʔt]	*infaqt*	'I spent'	/**dd**ɐhhal/→[ɪ**d.d**ɐh.hal]	*iddaħħal*	'to be inserted'
/**rb**ɐht/→[ɪ**r.b**ɐht]	*irbaħt*	'I won'	/**vv**ɔtɐ/→[ɪ**v.v**ɔː.ta]	*ivvota*	'to vote'

Unlike word-initial geminates and sonorant-initial clusters, obstruent-initial clusters do not trigger epenthesis. Obstruent + obstruent (e.g., /pt, bd, sf/) or obstruent + sonorant (e.g., /tl, km/) do not trigger epenthesis before the first consonant or between the two consonants. This is in contrast to other varieties of Arabic, which break up word-initial clusters by inserting an epenthetic vowel between C_1 and C_2 in the cluster (cf. Watson 2007; Kiparsky 2003). In addition there are other dialects in which the epenthetic vowel is before C_1, e.g., [ismiʕt] 'I heard' in Cyrenaic Arabic (cf. Mitchell 1960).[14]

[13]Unless such the sonorants are treated as syllabic.

[14]We would like to thank one of our reviewers for pointing out this reference.

Following the principle of Prosodic Licensing, which "requires all phonological units [to] belong to higher prosodic structure" (Itô 1986: 3), epenthesis allows the syllabification of otherwise unsyllabifiable consonants. Furthermore, the principle of Prosodic Licensing ensures that each segment in the phonological string is syllabified. Therefore, for syllabification to take place, segments must belong to higher prosodic structures such as syllables. Any segments that are not linked to syllables must be dealt with in order to satisfy Prosodic Licensing. Epenthesis can be explained through the syllabification of stray consonants as posited by Itô 1986; 1989. Following Itô's directionality of syllabification, we postulate that syllabification takes places from right to left. The process of syllabification in Maltese allows for Stray Epenthesis (Itô 1986), where stray consonants are syllabified precisely because a vowel is inserted, providing a new syllable for such consonants to be parsed by. Maltese, unlike Korean or Attic Greek, does not allow for Stray Erasure, where stray consonants are deleted from the phonological string. Evidence for this comes from production studies of word-initial geminates in Maltese, which shows that the duration of the geminate is longer than that of singletons (cf. Galea et al. 2015).

Therefore, the sonorant in sonorant-initial consonant clusters and the first part of the geminates in word-initial geminates trigger Stray Epenthesis (Itô 1986). These segments are not deleted but trigger epenthesis as all segments in a phonological string have to be syllabified. Following Stray Epenthesis, the sonorant in the consonant clusters (e.g., /lt/ in (16)) and the first part of the geminate (e.g., /ff/ in (17)) become the coda of a preceding syllable. The epenthetic vowel fills in the nucleus of the preceding syllable (cf. (17) below).

(16) Right-to-left syllabification of sonorant-initial clusters

[ltɪːm]	ltiem 'orphan'
.tɪːm	
*l.tɪːm	
ɪl.tɪːm	

(17) Right-to-left syllabification of word-initial geminates

[ɪffɪrmɐ]	ffirma 'to sign'
.mɐ	
fɪr.mɐ	
*f.fɪr.mɐ	
ɪf.fɪr.mɐ	

In addition, any of the prefixes that can be added to a verb serve as an onset to this added syllable (cf. Figure 1). For instance, the first person imperfect prefix

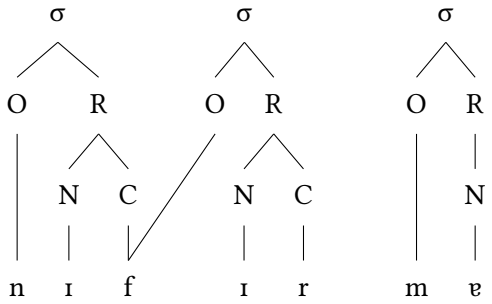

Figure 1: Syllabification of the inflected verb form [nɪffɪrmɐ] 'I sign'
In the representation of geminates, geminates are associated to the coda and onset slots; and it is assumed that these double associations represent the geminates. Such a representation is widespread within the literature on geminates, and we follow Davis (2011) with respect to conventions for geminate representations with respect to syllable structure.

/n-/ can only be added before the epenthetic vowel, thus a form like **nffirma* is banned (cf. (18)). The result is a syllable with an epenthetic vowel as its nucleus and the prefix as an onset.

(18) Syllabification of imperfect prefix /n-/ 'n'

[n-ffɪrmɐ]	niffirma 'I sign'
.mɐ	
fɪr.mɐ	
nɪf.fɪr.mɐ	

A reviewer points out that this rule does not explain why **inffirma* is ruled out given that in Maltese there is a comparable form *nfired* 'to be separated'. However, Maltese syllable structure does not allow for a cluster made up of a morphological prefix and a word-initial geminate (i.e., such as *i**nff**irma); on the other hand, it allows for a cluster made up of a morphological prefix and a singleton (such as *nfired* 'to be separate').

Following Nespor & Vogel (1986) we take this to be the domain of the prosodic word as it consists of a stem (i.e., the verb) and a prefix which is added as a result of morphological inflection (as in the case of *niffirma* in (20)) or derivation. This is also reinforced by Selkirk (1996)'s proposal that the left and the right edges of words coincide with the left and right edges of the prosodic word, which was subsequently adopted for Maltese by Kiparsky (2011) and Wolf (2011). Therefore, word-initial geminates which result due to a morphophonological process are part of a single prosodic word, as in (19).

(19) Prosodic Word (PWd)

a. [ɪffɪrmɐ]$_{\text{PWd}}$
ffirma
'to sign'

b. [nɪffɪrmɐ]$_{\text{PWd}}$
niffirma
'I sign'

Furthermore, the application of Stray Epenthesis applies in phonological-initial position and when the previous word ends in a consonant (as in (20)):

(20) Syllabification of word-initial geminates
[luːk.ɪv.vɔː.tɐ]
Luke ivvota
'Luke voted'

In cases where the word before sonorant-initial and word-initial geminates ends in a vowel, a number of strategies can be invoked. Hoberman & Aronoff (2003) claim that the prothetic vowel before word-initial geminates does not occur when the preceding word ends in a vowel. We claim that in such cases, we find cross-morpheme and cross-word boundary syllabification. When a previous word ends in a vowel, the stray consonant in the following word serves as a coda to that syllable, which results in cross-word syllabification, as in (21).

(21) Cross-word syllabification: word-initial geminates
[.(ʔ)ɐn.dɐ**d**.dɐh.hɐl.]
għandha ddaħħal
'she has to enter'

Another strategy is Stray Epenthesis, resulting in an inserted vowel before the word-initial geminate, as in (22).

(22) Across word syllabification: word-initial geminates
[.(ʔ)ɐn.dɐ.ɪ**d**.dɐh.hɐl.]
għandha ddaħħal
'she has to enter'

On the other hand, unlike sonorant-initial clusters or word-initial geminates, Stray Epenthesis does not operate with obstruent-initial consonant clusters. Obstruent-initial consonant clusters are tautosyllabic and the first consonant is not syllabified as the coda of a previous vowel-final word, as in (23).

(23) Onset clusters
[hɐf.**nɐ.ptɪ**ː.hɪ]
ħafna btieħi
'a lot of inner courtyards'

2.2 Summary

In this chapter, we have presented an overview of some of the key phenomena related to the phonetics and phonology of Maltese syllables. More concretely, we outlined the possible syllable structures that can occur as monosyllables and within words in Maltese. As a matter of fact, this can be directly compared with the possible syllable structures of some varieites of Arabic, Italian, and English (the languages from which Maltese originates). Therefore, we propose that a fruitful future study would involve comparing descriptions of syllable structures in Maltese and of the languages Maltese originates from.

This chapter also showed that the possibilities of onset clusters in Maltese are not very heavily restricted. Specifically, Maltese allows for both low sonority distance (e.g., /.pt…/) and high sonority onset clusters (e.g., /.tl…/). Moreover, in the low sonority distance onset clusters, Maltese permits sonority reversals and sonority plateaus. Therefore, even though the sonority framework was used to describe the possible clusters in Maltese, some problems remain. A thorough phonetic analysis using experimental techniques such as an articulography can shed light on the syllable affiliation and possible syllabification of such different clusters by looking at the gestural overlap and the timing of the gestures.

In comparing onset clusters and word-initial geminates, we have shown that word-initial geminates (e.g., /.pp…/) behave similarly to sonorant-initial clusters (e.g., /.lt…/), where they tend to be preceded by an epenthetic vowel. We argued that sonorant-initial clusters and word-initial geminates in Maltese are banned in the phonology and the presence of a preceding vocalic insertions leads to a process of resyllabification.

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