Conditions on /t/-insertion in Maltese numeral phrases: a reassessment

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Abstract

There has, for a considerable period, been disagreement and confusion as to the conditions governing the appearance of the /t/ morpheme that sometimes intervenes between the numerals 2–10 and a following plural noun in Maltese, as in *ħames skejjel / ħamest iskejjel* 'five schools' (e.g. Aquilina 1965: 118, Borg 1974, Cremona 1938: 204–5). In recent work (Lucas and Spagnol 2016) we reported on a native-speaker production experiment designed to improve our understanding of this issue. The results of that experiment suggested that the key factor determining /t/-insertion was onset of the plural noun: CV-initial plurals virtually never permit /t/-insertion, whereas CC-initial and V-initial plurals at least sometimes do. Number of syllables also appeared to be a relevant factor, in that, e.g., monosyllabic CC-initial plurals were found to strongly favour /t/-insertion, disyllabic CC-initials less so, and polysyllabic CC-initials not at all.

The present work builds on this earlier research, arguing that a more accurate and more general statement of the conditions on /t/-insertion is one that makes reference primarily to morphological pattern, rather than to onset and number of syllables. This conclusion stems from a new production experiment focusing specifically on /t/-insertion with CC-initial disyllabic plurals. The experiment tested combinations of numerals with a number of both 'sound' (suffixing, non-stem-altering) plurals and 'broken' (non-suffixing, stem-altering) plurals. The latter fell into one of three patterns: CCVVCV(C), CCVjjVC and CCVCVC. The basic prediction was that the broken plurals would, in general, be much more favourable to /t/-insertion than the sound plurals. This prediction was borne out (broken plural mean insertion rate: 32%; sound plural mean insertion rate: 5%). Additionally, we predicted that broken plurals of the CCVCVC pattern, such as *gwerer* 'wars', in which two consonants occupy the initial root-consonant slot in the basic, highly /t/-resistant, CVCVC pattern (cf. Mifsud 1994), would be less favourable to /t/-insertion than the other CC-initial broken plural patterns tested. This too was borne out (mean insertion rates: CCVCVC 23%; CCVjjVC 37%; CCVVCVC 55%). Taken together, these two findings show that morphological pattern

should be taken as the key determinant of /t/-insertion, with onset and number of syllables contributing only secondarily.

1 Introduction

1.1 Overview

In a recent article (Lucas and Spagnol 2016), the present authors made a first attempt at a definitive statement of the conditions governing so-called */t/-insertion* in Maltese numeral phrases. We provided experimental evidence that the incidence of /t/-insertion correlates strongly with phonological properties of the nominal head of a numeral phrase. The present article shows, on the basis of new experimental evidence, that, notwithstanding our earlier findings, /t/-insertion is better seen as a morphologically-governed phenomenon, and that the apparent role of phonology is at least partly epiphenomenal.

1.2 What is /t/-insertion?

Maltese cardinal numerals from 'two' to 'ten' have two main forms: a DEPENDENT form, used when the numeral modifies a following plural noun, and an INDEPENDENT form for non-modifier uses. The dependent form comes in two versions, however: with or without /t/.[1] This is illustrated in Table 1 and the example in (1), in which it can also be seen that /t/-insertion before a plural noun beginning with a consonant cluster triggers insertion of a prothetic /i/.

(1)
a.   *ħames   skejjel*
b.   *ħamest   iskejjel*
          'five   schools'

    As can be seen from (1), *skejjel* 'schools' is an example of a Maltese plural for which /t/-insertion with a preceding numeral is optional, at least for some speakers. As we will see, there are dozens of Maltese plurals with this property, though the previous literature on /t/-insertion sometimes gives the impression that this is a non-optional process (e.g. Cremona 1938: 204–5, Sutcliffe 1936: 188–9). In fact, this literature (e.g. Borg 1974, Cremona 1938: 204–5, Fabri 1994) is characterized by a remarkable lack of consensus on the details of what triggers /t/-insertion. To take the most striking example: Aquilina (1965: 118) suggests that /t/-insertion is licit with any plural with a vocalic onset, while Borg (1974: 294) claims that plurals with vocalic onsets are the precise context in which /t/-insertion does not occur. Despite this lack of consensus, there is nevertheless general agreement that the most

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[1] Maltese orthography treats this /t/ as a suffix on the numeral, but phonologically it behaves as a prefix on the following plural noun (see Lucas & Spagnol 2016 for details). We follow Maltese orthography here, but will refer to this morpheme simply as /t/, not as a suffix.

important factors governing /t/-insertion are the **onset** and **number of syllables** of the plural noun (for further details on the previous literature on this topic, see Lucas and Spagnol 2016).

	Independent form	**Bare dependent form**	**Dependent form with /t/**
'two'	tnejn	żewġ / ġiex	żewġt / ġixt
'three'	tlieta	tliet	tlitt / tlett
'four'	erbgħa	erba'	erbat
'five'	ħamsa	ħames	ħamest
'six'	sitta	sitt	sitt
'seven'	sebgħa	seba'	sebat
'eight'	tmienja	tmien	tmint
'nine'	disgħa	disa'	disat
'ten'	għaxra	għaxar	għaxart

Table 1: Independent, bare dependent and dependent /t/-form cardinal numerals 2–10 in Maltese.

1.3 Previous experiment

Our aim in Lucas & Spagnol (2016) was to put the description of this construction on a firmer footing by testing these two factors experimentally with multiple native speakers. All earlier work on this topic had depended on authors' personal intuitions or informal observations. Accordingly, we recruited 35 native speakers of Maltese for a production experiment. In this experiment the test items were pairings of a numeral between 'two' and 'ten' (presented as a figure) and one of 56 singular nouns whose plurals fell into eight different categories: mono-, di- and polysyllabic (3+) CC-initial words; mono-, di-, and polysyllabic CV-initial words; and di- and polysyllabic V-initial words (there being no monosyllabic V-initial plurals in Maltese). The subjects' task was then to produce what they saw, as the phrase would naturally occur in context, i.e. with the numeral in the dependent form, the noun in the plural, and with /t/-insertion if considered appropriate.[2] For example, if our target were as in example (1) above, the test item would appear as in (2), *skola* being the singular 'school'.

(2)   5   skola

The results of this experiment showed that, among our 56 test items, there was indeed a very

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[2] The task was demonstrated by means of examples, not explained conceptually. Subjects were asked after the test (which included equal numbers of test and filler items) whether they had any idea what it was investigating. None realized that /t/-insertion was the topic of investigation.

strong main effect of both onset and number of syllables in the incidence of /t/-insertion.[3] This can be clearly seen from Figure 1.
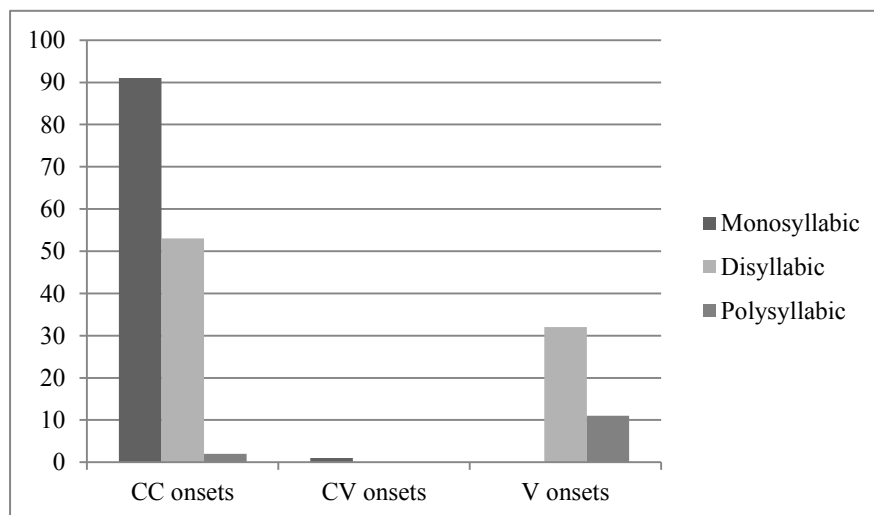

Figure 1: /t/-insertion rates (%) by onset and number of syllables (adapted from Lucas and Spagnol 2016)

In this dataset, /t/-insertion is essentially absent with plurals with CV onsets, no matter the number of syllables. With CC onsets the picture is entirely different, and number of syllables appears to be crucial: monosyllabic CC-initial plurals tested trigger /t/-insertion approximately 90% of the time, disyllabic CC-initial plurals approximately 50% of the time, and polysyllabic CC-initial plurals essentially never. With V initials, matters are much less clear cut: neither disyllabics nor polysyllabics particularly favour /t/-insertion, but polysyllabics do so noticeably less than disyllabics, though without disallowing it altogether.

As we noted in the earlier article, however, there is likely more to these results than meets the eye. In the previous literature on this topic, Borg (1974: 297) and Ambros (1998: 91) both suggest that the distinction between 'sound' and 'broken' plurals plays an important role in the occurrence of /t/-insertion. This distinction, which Maltese inherits from Arabic, concerns the morphological means by which plural number is indicated on nouns and adjectives. Sound plurals are those in which plural is indicated by suffixation of a plural morpheme to the singular form, with little or no alteration to the stem, as in *kelma* 'word', *kelm-iet* 'word-PL'. Broken plurals, by contrast, are those in which plural is indicated by means of an abstract 'pattern' morpheme – a vocalic melody that combines with the root consonants of the word in question, as in *kelb* 'dog', *klieb* 'dog.PL'. Borg (1974: 297) claims that "sound plurals do not take /t/".

It was not possible to include the sound vs. broken plural distinction as another factor in the experiment reported on in Lucas & Spagnol (2016), as this would have necessitated an impractically large number of test items. We did, however, ensure that both sound and broken

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[3] The experiment also tested a third factor: choice of specific numeral between 2 and 10. We found no main effect of this factor, though there was an interaction of all three factors. See section 2.2 of the present article and Lucas & Spagnol (2016) for further details.

plurals were represented as test items in all the conditions where this was possible, so as to gain some preliminary insights as to the relevance of this factor. For example, a /t/-insertion rate across all 35 subjects of 20% with the sound plural *ajruplani* 'aeroplanes' (sg. *ajruplan*), and 26% with the sound plural *idejn* 'hands' (sg. *id*), suggests that Borg's claim cannot be completely correct, at least as far as vowel-initial plurals are concerned. Regarding CV-initial plurals, we have already seen that none of these were favourable to /t/-insertion, and this was true for both sound and broken plurals. The most interesting case was that of the CC-initial plurals. Recall that, with these, the incidence of /t/-insertion varied sharply according to the number of syllables, with /t/-insertion rates of around 90% with monosyllabics, around 50% with disyllabics, and essentially zero with polysyllabics. A crucial point to realise here, however, is that, among CC-initial plurals in Maltese, there are no polysyllabic broken plurals and no monosyllabic sound plurals. So the results for these two conditions cannot help us determine the relative importance to /t/-insertion of number of syllables and the sound vs. broken plural distinction. With disyllabic CC-initials, on the other hand, both sound and broken plurals are amply represented. Table 2 shows the CC-initial disyllabic plurals tested in Lucas & Spagnol (2016) along with the frequency with which our test subjects inserted /t/ with these items.

	Test items		/t/-insertion frequency (%)
Broken plurals	bramel	'buckets'	74
	ġranet	'days'	77
	skejjel	'schools'	56
	ljieli	'nights'	80
	kmamar	'rooms'	71
Sound plurals	platti	'plates'	7
	stampi	'pictures'	6

Table 2: /t/-insertion rates for CC-initial disyllabic plurals (adapted from Lucas and Spagnol 2016).

We see that /t/-insertion rates for the two sound plurals are close to zero, while for the broken plurals they are much higher. It therefore seems that Borg's (1974: 297) claim (that /t/-insertion is incompatible with sound plurals), while not absolutely correct, is certainly on the right track. This and related issues were investigated in detail in the experiment reported on in the following sections.

2 New experiment

2.1 Rationale and predictions

The purpose of the follow-up experiment that we report on here was twofold: a) to investigate the relevance of the sound vs. broken plural distinction to /t/-insertion rates; and b) more generally, to tease apart the relative importance to /t/-insertion of phonological and morphological factors. We approached these problems by focusing in detail on just one of the seven conditions investigated in the first experiment: CC-initial disyllabic plurals (both broken and sound). Restricting our investigations to these was the natural choice for a variety of reasons. Since we have already established that onset and number of syllables correlate strongly with patterns of /t/-insertion, it makes sense to hold these constant while examining whether other factors play a role. We have already seen that CV-initial plurals – both broken and sound – are very hostile to /t/-insertion no matter the number of syllables, so these are not useful for further investigation (but see the discussion below of the morphologically related *gwerer*-type broken plurals), while the lack of monosyllabic CC-initial sound plurals and polysyllabic CC-initial broken plurals rules these out too. It would certainly be interesting to investigate further what combination of factors regulates /t/-insertion with V-initials, but since there is a relative paucity of V-initial broken plurals, we leave these aside for present purposes to focus on the disyllabic CC-initials, of which there is an abundance, both broken and sound.

Focusing on disyllabic CC-initial plurals allows us to test a number of hypotheses. First, and most straightforwardly, that broken plurals of this type are more favourable to /t/-insertion than phonologically equivalent sound plurals.

Second, it may be that not all broken plural patterns are favourable to /t/-insertion. There are three Maltese broken plural patterns that are CC-initial disyllabic: CCVVCV(C), with a long medial vowel, as in *bramel* 'buckets' (sg. *barmil*) and *qsari* 'flower pots' (sg. *qasrija*); CCVjjVC, with a medial geminate glide, as in *knejjes* 'churches' (sg. *knisja*); and, most significantly, CCVCVC, with two short vowels, as in *gwerer* 'wars' (sg. *gwerra*). This final pattern is significant because it features an initial consonant cluster in a morphophonological slot that in other Arabic and Semitic varieties, and most of the Maltese lexicon, would usually host just a single root consonant. The pattern CCVCVC is therefore one sub-type of the more general pattern (C)CVCVC, of which a more prototypical example than *gwerer* is *bozoz* 'bulbs' (sg. *bozza*), with three straightforward candidates for the three root consonants that this pattern typically requires. As can be seen from Table 2, we tested four plurals of the CCVVCV(C) type in the first experiment, and recorded /t/-insertion rates from 71% to 80% with these, and one of the CCVjjVC type, for which the /t/-insertion rate was 56%. We did not test any of the CCVCVC (*gwerer*) type. Among our CV-initial disyllabic test items, however, we tested one plural of the CVCVC type: *bozoz*. In keeping with all the other CV-initial plurals in the first experiment, there were no instances of /t/-insertion with *bozoz*. What this means is that CC-initial plurals of this pattern – like *gwerer* – are therefore an ideal testing ground for the idea, universal in the previous literature, that all CC-initial broken plurals are favourable to /t/-insertion. Our hypothesis is that, in reality, onset, like number of syllables, is only of secondary importance to /t/-insertion: we predict

that plurals of the *gwerer*-type, despite being CC-initial, will, like their CV-initial counterparts of the *bozoz*-type, be unfavourable to /t/-insertion, due to their membership of the same basic (C)CVCVC pattern.

Third, we saw from the results of the first experiment that /t/-insertion with CC-initial disyllabic broken plurals is by no means obligatory (see Table 2). This raises the question of whether any factors in addition to the specific broken plural pattern influence the frequency of /t/-insertion where this is optional. It seems plausible that various factors do indeed play a role. For example, we hypothesized in Lucas & Spagnol (2016) that the 'string frequency' in corpora (Krug 1998) of specific numeral–noun combinations would correlate with frequency of /t/-insertion for nouns where this is optional. This is something we are investigating in presently ongoing work and will not take further here. Another factor that could plausibly play a role here is the precise phonetic composition of the onset. As shown in (1), /t/-insertion also triggers insertion of a prothetic /i/ with non-V-initial plurals. Prothetic /i/-insertion elsewhere in Maltese grammar is sensitive to the precise composition of initial consonant clusters (see section 3.3 for details), so it would not be a surprise to find that this also has an effect on rates of /t/-insertion where this is optional. We had no grounds to formulate a specific hypothesis in relation to this point, but we made sure to test plurals with as wide a range of CC onsets as possible (see section 2.2 for more details), so that we could discover any structured variation that does exist in this domain.

From another perspective, it also seems likely, given the findings of half a century of variationist sociolinguistics (cf. Chambers 2003), that, where /t/-insertion is optional, this linguistic variation will have been co-opted to index one or more social variables. In the experiment reported in Lucas & Spagnol (2016), we found no effect of gender or age, but recall that in that experiment we found little or no optionality of /t/-insertion for the majority of conditions (see Figure 1 above), meaning the scope for sociolinguistic variation was limited. What optionality we did observe in that experiment was concentrated, as noted above, in the CC-initial disyllabic condition that is the focus of the present investigation. It makes sense, therefore, to revisit the possibility of sociolinguistic variation here. We cannot know at present whether variable /t/-insertion is stable or represents a change in progress. If it is the latter, we would expect to find that /t/-insertion behaviour varies according to the speakers' age, as well as their gender, since it is a well-established finding of variationist sociolinguistics (e.g. Labov 2001) that females tend to be more linguistically innovative than males. As a practical matter, it proved impossible in the period available for this research to recruit adequate numbers of subjects representing age groups higher than that of undergraduate university students. We ensured, however, that males and females were equally represented among are subjects, so that any gender-based differentiation in /t/-insertion could also be readily discovered.

Finally, while our principal hypothesis is that sound plurals will be relatively unfavourable to /t/-insertion, research into exemplar-based linguistic processing (e.g.

Rumelhart & McClelland 1986, Bod 1998, Eddington 2009) leads us to hypothesize that sound plurals will not be totally incompatible with /t/-insertion (cf. also the non-zero results from the previous experiment for the sound plurals *platti* 'plates' and *stampi* 'pictures' shown in Table 2), and, moreover, that /t/-insertion with sound plurals will be sensitive to their phonological similarity to the broken-plural patterns that favour /t/-insertion. We therefore selected plurals to test that varied according to two parameters. First, suffix type: we ensured that all three of the most frequently occurring sound plural suffixes for disyllabic plurals – -*iet*, -*i* and -*s* – were represented among the test items. Note that the items taking the -*iet* plural suffix, such as *brimbiet* 'spiders' (sg. *brimba*), have final stress, whereas items taking the other two suffixes, such as *gruppi* 'groups' (sg. *grupp*) and *stejpils* 'staples' (sg. *stejpil*), have initial stress. All CC-initial disyllabic broken plurals have initial stress, so we predict that sound plurals with the -*iet* suffix will be less favourable to /t/-insertion than those with the suffixes triggering initial stress. Second, we chose sound-plural items that varied according to the nature of the first syllable, specifically whether or not it resembled that of the two broken plural patterns we predicted would favour /t/-insertion: CCVVCVC and CCVjjVC. Thus we had items with a long vowel in the first syllable, e.g. *stili* 'styles' (sg. *stil*), or with a medial geminate, e.g. *vjaġġi* 'journeys' (sg. *vjaġġ*), and others without these properties, e.g. *spaners* 'spanners' (sg. *spaner*). Since a number of the items that fall into the latter category have a light first syllable (i.e. a short vowel and no coda), for convenience we henceforth refer to the whole category as 'light first syllable', as opposed to 'heavy first syllable' for items of the *stili/vjaġġi* category.[4]

The following section gives details on the design of the experiment.

2.2 Experiment design

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[4] Note, however, that a number of items in the 'light' category do, in fact, have a coda (e.g. *flipflops*). The label is thus for brevity and convenience only. The key distinguishing feature for this factor is resemblance to the broken plural patterns CCVVCVC and CCVjjVC.

The basic design of the experiment followed that of the first experiment, reported on in section 1.3. Subjects were recruited from the University of Malta, their ages ranging from 18 to 22. The experiment was split into a broken-plural section and a sound-plural section. 20 subjects (10 male, 10 female) took the sound-plural part. The same 20, and 10 more (5 male, 5 female) took the broken-plural part. In the broken-plural part there were 70 test items and an equal number of fillers, and in the sound-plural part there were 49 test items and an equal number of fillers.[5]

As in the first experiment, test items consisted of a pairing of a numeral between 'two' and 'ten', presented as a figure, and the singular form of the plural noun we were targeting, the task being to realise the phrase as it would be in context: the noun in the plural and the numeral in the dependent form, and /t/ optionally inserted between the two. Refer to Table 1 for all forms of the Maltese numerals 'two' to 'ten'. In the experiment, the numeral was in fact just one of the following seven: 2, 4, 5, 7, 8, 9, 10. *Tliet* 'three' (/t/-form *tlitt/tlett*) and *sitt* 'six' (/t/-form *sitt*) were not included because, in the case of the former, the /t/-form and non-/t/-form are too similar phonetically to reliably tell apart phonetically every time, and, in the case of the latter, the two forms are identical.

Since our aim in this second experiment was primarily to investigate the effect of phonological and morphological properties of the plural noun itself, holding other factors constant as far as possible, we considered pairing the different nouns with the same numeral every time: *ħames(t)* 'five', for example. We decided against this, however, for two reasons. First, as noted in footnote 3, the results of the first experiment showed there was no main effect of numeral choice on rates of /t/-insertion. So including various numerals in the test stimuli or always just the same one ought not to have a statistically significant effect on the variable we are investigating. Second, we suspected that always having the same single numeral in the stimuli would make it too easy for test subjects to correctly guess precisely what the experiment was designed to investigate – something we successfully avoided (cf. footnote 5). As such, we used the seven numerals specified above and each was used an equal

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[5] The decision was made to split the experiment into a sound-plural and a separate broken-plural section, rather than combining them into a single dataset, because we were confident, based on the previous literature and informal observation, that the difference in /t/-insertion rates between the two plural types would be totally apparent, removing the necessity to analyse the broken/sound distinction as an additional fixed effect within a single dataset. This confidence was borne out by the results reported in section 3.1. Splitting the experiment in this way had two advantages. First, it meant that in each of the two sections the test items could be coded differently, and different hypotheses could be tested. Second, it meant that we could collect more data without having to ensure equal numbers of subjects for both sections. Limited time to carry out this research imposed constraints on the preparation and use of test materials. The broken-plural test materials were ready first and were used to collect data from ten subjects immediately. At the next opportunity for data collection, the sound-plural materials were ready, and so both sets of materials were then used to collect data from 20 further subjects. These 20 took the broken-plural test first, then the sound-plural part after a short break, so that all 30 subjects took the broken-plural test under identical conditions. It is possible that having subjects take the sound-plural test after the broken-plural one resulted in some kind of priming effect, but note that all subjects were asked after completing both tests what they thought the topic of the investigation was, and none ascertained its true purpose.

number of times: with ten nouns in the broken-plural part (70 test items ÷ 7) and seven nouns in the sound-plural part (49 test items ÷ 7).

As in the first experiment, fillers, which alternated regularly with test items, consisted of pairings of a numeral between 'eleven' and 'nineteen' and a noun, the nouns varying widely according to onset and number of syllables. Note that the noun following a numeral from the 11–100 set is always in the singular, and thus never triggers /t/-insertion.

The first six stimuli (including fillers) that subjects encountered in the broken-plural and sound-plural parts of the experiment are illustrated in (3) and (4), respectively. Stimuli were presented in a PDF file on a laptop, with one stimulus per page, a page filling the screen. Subjects had to produce the appropriate form in response to the onscreen stimulus and scroll down to the next page of the PDF having done so. Their responses were given orally and the audio recorded. Responses were categorized independently by both authors, according to whether each one featured /t/-insertion or not. If the presence of /t/-insertion in an individual response was unclear to one or both authors it was categorized as NA.

(3)   Broken-plural test items and fillers

a.   12   qasba
b.   2   qasrija   (target: *żewġ(t i)qsari*)
c.   13   bandiera
d.   5   raħal   (target: *ħames(t i)rħula*)
e.   15   għalqa
f.   10   xkora   (target: *għaxar(t i)xkejjer*)

(4)   Sound-plural test items and fillers

a.   19   bniedem
b.   4   kwadru   (target: *erba(t i)kwadri*)
c.   16   ħabsi
d.   5   brama   (target: *ħames(t i)bramiet*)
e.   11   gallarija
f.   4   slogan   (target: *erba(t i)slogans*)

The nouns to be tested were selected as follows (a full list can be found in Table 4 and Table 5 in section 3). With the broken plurals first of all, the three patterns CCVVCV(C), CCVjjVC, and CCVCVC had to be represented. It should be noted here that plurals from the first of these patterns are far more numerous than plurals from the other two (and CCVjjVC is much more frequent than CCVCVC). Since the plurals selected had to be fairly frequent and familiar to our young, mostly town-dwelling subjects, and we also wanted a reasonable balance of different onset types, we chose not to have equal numbers of test nouns from each of the three patterns. Instead, there were ten plurals of the CCVCVC pattern, 15 of the CCVjjVC pattern, and 45 of the CCVVCV(C) pattern.

Onset Types	No. of Tokens	Example	
STOP-STOP	6	*qtates*	'cats'
STOP-FRICATIVE/AFFRICATE	6	*gżejjer*	'islands'
STOP-SONORANT	9	*drabi*	'times'
AFFRICATE-STOP	2	*ġkieket*	'jackets'
AFFRICATE-SONORANT	6	*ċwievet*	'keys'
FRICATIVE-STOP	8	*stilel*	'stars'
FRICATIVE-FRICATIVE/AFFRICATE	5	*ħxejjex*	'vegetables'
FRICATIVE-SONORANT	9	*flieles*	'chicks'
SONORANT-STOP	5	*mkatar*	'handkerchiefs'
SONORANT-FRICATIVE/AFFRICATE	6	*rġejjen*	'queens'
SONORANT-SONORANT	4	*mrietel*	'hammers'
/sk/-SONORANT	4	*skrapan*	'shoemakers'

Table 3: The broken plural test items by onset type

Regarding onset, the 70 broken-plural test items selected fell into the 12 categories listed in Table 3.[6] This categorization also entails less fine-grained categorizations of course, such as a three-way division into stop-initial (including affricate-initial; 29 tokens), fricative-initial (26 tokens), and sonorant-initial (15 tokens), or a binary division into sonorant-initial (15 tokens) and others (55 tokens).

Turning to the sound-plural test items, we extracted all 225 CC-initial disyllabic sound plurals recorded in Aquilina's (1987–1990) dictionary. Most of these were archaic and/or infrequent and had to be discarded. Among the remainder, the most commonly represented plural suffix was *-i*, as in *sferi* 'spheres' (sg. *sfera*), followed by *-iet*, as in *brimbiet* 'spiders' (sg. *brimba*), then *-s*, as in *slogans* 'slogans' (sg. *slogan*). We selected all tokens of the latter two plural types that we judged sufficiently frequent and familiar (11 tokens of each type) and 27 of the more familiar tokens of *-i* plurals, choosing items with a range of onset types and initial-syllable weights. Of this total of 49 sound-plural tokens, 19 had a light initial syllable, and the remaining 30 had a heavy initial syllable.

3 Results

3.1 Basic finding

The headline result is that the key hypothesis – that /t/-insertion rates are sensitive to the

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[6] Given the presence of the /sk/–SONORANT-initial items, the abbreviation 'CC' in this article should be understood as standing for 'consonant cluster' in general, rather than for a cluster of exactly two consonants. That said, two-consonant onset clusters are much more numerous than three-consonant onset clusters, both in our test items and in Maltese generally.

sound vs. broken plural distinction – is strongly confirmed. The mean /t/-insertion rate for all broken plurals tested was 32%, while for all sound plurals tested it was 5%. However, the results are far from uniform in either set of test items, and particularly with the broken plurals, as can be seen in **Error! Reference source not found.**. The reasons for this heterogeneity are explored in the following sections. The full list of items tested, together with the per item results, can be found in Table 4 and Table 5.

3.2 Effect of broken plural pattern

The data for the broken plurals was analysed with a linear mixed effects model (using the 'glmer' function in R), with random intercepts for test item and test subject, and pattern (CCVVCV(C), as in *bramel*, CCVjjVC, as in *knejjes* and CCVCVC, as in *gwerer*) as a fixed effect. This confirmed the prediction that the *gwerer*-type CCVCVC pattern is less favourable to /t/-insertion than the other two: there was a statistically significant difference both between the CCVjjVC pattern and the CCVCVC pattern ($z = 2.394$, $p = 0.012$), and between the CCVVCV(C) pattern and the CCVCVC pattern ($z = 5.219$, $p < 0.0001$). The mean rates of /t/-insertion for the three patterns were as follows: CCVVCVC, 55%; CCVjjVC, 37%; CCVCVC, 23%.[7] The overall main effect of pattern (disregarding the random effects for item and subject) is illustrated in Figure 3 (created using the R package 'effects'; error bars represent 95% confidence intervals).
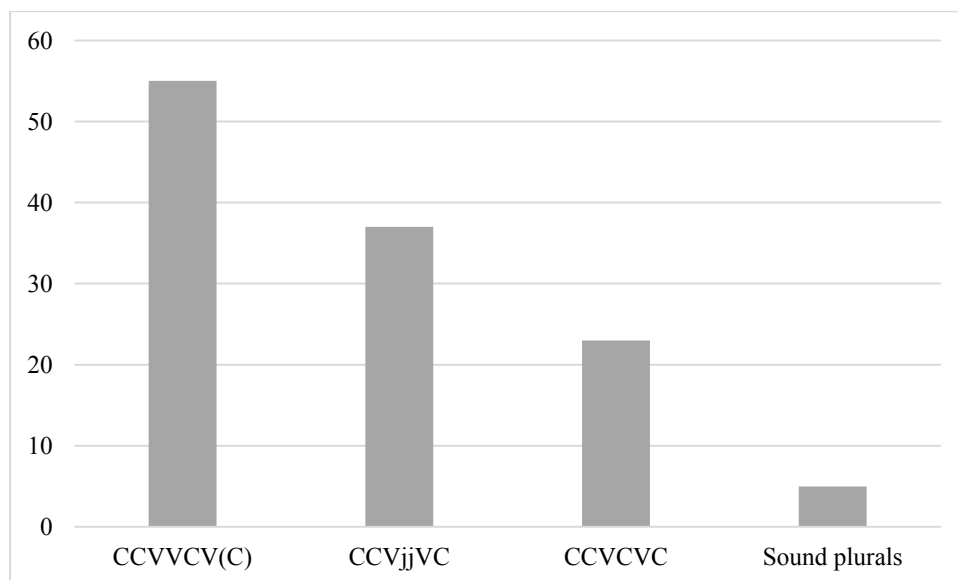

Figure 2: /t/-insertion rates (%) for the three broken plural patterns and for sound plurals

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[7] The difference between the CCVVCV(C) and CCVjjVC patterns is also statistically significant ($z = -2.394$, $p = 0.017$).
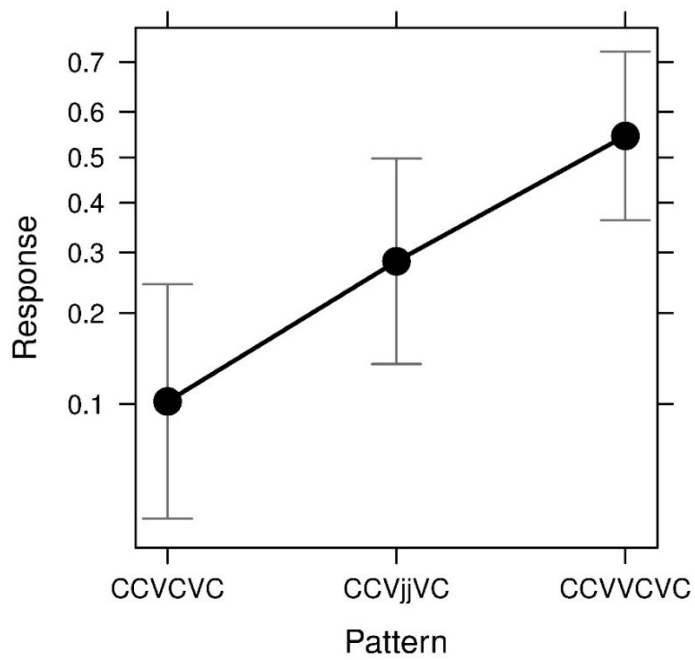
Figure 3: Plot of pattern effect for broken plural data

Test items	Meaning	% /t/	Test items	Meaning	% /t/
qsari	flower pots	87%	skieken	knives	46%
slaleb	crosses	87%	skrataċ	cartridges	45%
ħnieżer	pigs	87%	rwiefen	gales	44%
qtates	cats	86%	sfafar	whistles	44%
flieles	chicks	85%	ċrieket	rings	43%
ġkieket	jackets	79%	bziezen	bread rolls	43%
kpiepel	hats	76%	msielet	earrings	41%
żwiemel	horses	73%	*ħxejjex*	vegetables	*41%*
qniepen	bells	73%	*ħrejjef*	fables	*39%*
dbielet	skirts	72%	ċpiepet	bracelets	37%
drabi	times	67%	**MĦADED**	pillow	**37%**
blalen	balls	67%	*xmajjar*	rivers	*36%*
ċmieni	chimneys	67%	*skejjel*	schools	*33%*
kwiekeb	stars	65%	ktieli	kettles	33%
sħaħar	wizards	64%	bdiewa	farmers	32%
mwejjed	tables	*64%*	mkatar	handkerchiefs	31%
bżieżaq	balloons	63%	ċraret	pcs of cloth	30%
ħbula	ropes	62%	*nbejjed*	wines	*30%*
skrejjen	propellers	*62%*	zlazi	sauces	30%
xfafar	blades	62%	*xkejjer*	sacks	*29%*
skrapan	shoemakers	59%	**GWERER**	wars	**28%**
knejjes	churches	*57%*	*stejjer*	stories	*27%*
ċwievet	keys	56%	rkiekel	bobbins	26%
rdieden	sp. wheels	56%	*gżejjer*	islands	*23%*
ġrieden	mice	54%	msiemer	nails	20%
ħwienet	shops	53%	**SKWERER**	set-squares	**19%**
rziezet	farms	53%	**PLAKEK**	plugs	**17%**
XKAFEF	shelves	**53%**	**VLEĠEĠ**	arrows	**15%**
mrietel	hammers	53%	*rġejjen*	queens	*15%*
qżieqeż	piglets	52%	**STILEL**	stars	**13%**
ktajjen	chains	*50%*	twieqi	windows	13%
rħula	villages	48%	**SPONOŻ**	sponges	**13%**
mqaret	date pastries	48%	**PJAZEZ**	squares	**10%**
rwejjaħ	smells	*46%*	*ħsejjes*	sounds	*3%*
kxaxen	drawers	46%	**FLOTOT**	fleets	**0%**

Table 4: CC-initial disyllabic broken plurals – test items and /t/-insertion rates

Key:

CCVVC(C):   plain typeface

CCVjjVC: **bold italics**

CCVCVC: **BOLD CAPS**

3.3 Effect of onset and gender

As explained in section 2.2, the factor of onset can be viewed as having different numbers of levels. We coded the onsets of the broken plural test items three ways: with the twelve levels detailed in section 2.2; with the three levels 'stop-initial', 'sonorant-initial', and 'other'; and with the two levels 'sonorant-initial' and 'other'. As explained further below, choosing the presence or absence of a sonorant as the criterion for dividing onset into two levels is motivated by independently established facts concerning the differential phonological behaviour of sonorant-initial and non-sonorant-initial words in Maltese.

Adding onset (whether with twelve, three or two levels) as a fixed effect to the model described in the previous section does not result in increased statistical significance for the effect of pattern, and the effect of onset itself on /t/-insertion is not statistically significant. The same is true of gender. However, when we add an interaction between gender and onset (with just two levels) to the model, alongside pattern, onset, and gender as fixed effects, we find that the interaction between onset and gender is statistically significant ($z = 2.292$, $p = 0.0219$). While there is no significant difference between sonorant-initial and non-sonorant-initial items when it comes to male subjects' /t/-insertion behaviour, with female subjects there is a clear difference, as can be seen from Figure 4.
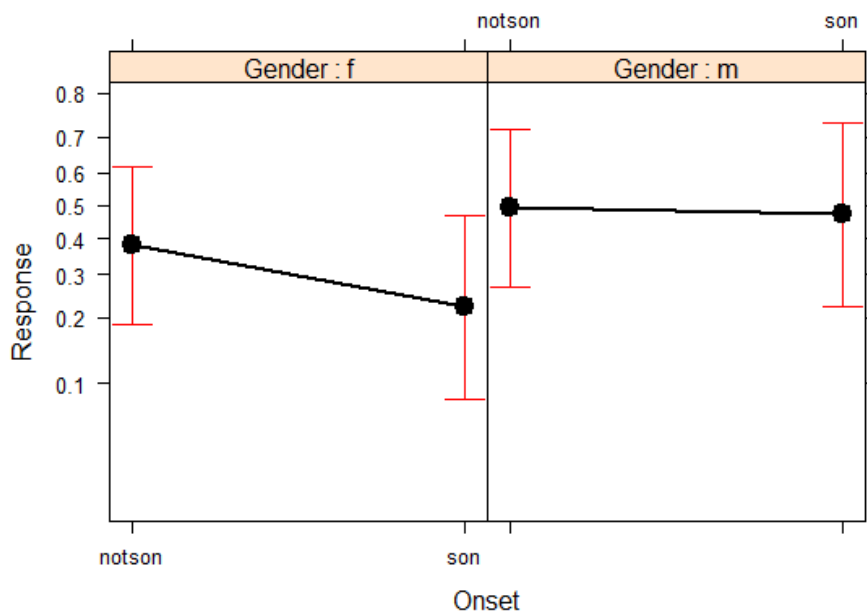

Figure 4: Plot of onset/gender interaction for broken plural data

Why would females insert /t/ less frequently with sonorant-initial broken plurals than they do with others, while with males there is no significant difference, bearing in mind that these are all young adults (between 18 and 22 years old)? This is a problem that requires

further detailed testing, but it might be understood as one manifestation of a wider change in progress in Maltese phonology, rather than just the narrow domain of /t/-insertion. Traditionally (e.g. Sutcliffe 1936: 16), Maltese is described as having words which underlyingly begin with a SONORANT–CONSONANT cluster, but which take a prothetic /i/ in non-postvocalic position. Galea (2016) shows, however, that, for at least some young speakers, this prothetic vowel may now appear in all contexts, suggesting that it has been reanalysed – or is in the process of being reanalysed – as part of the underlying representation of these words. As noted in section 2.1, variationist sociolinguistics (e.g. Labov 2001) has shown that young females tend to be at the forefront of changes in progress. Thus, although this is not something that Galea has demonstrated in his work, it makes sense to assume that young female Maltese speakers also treat these sonorant-initial words as underlyingly vowel-initial with greater frequency than males do. If this is indeed the case, then we have a possible explanation for the data illustrated in Figure 4. Recall from section 1.3 that we found in our first experiment that /t/ is inserted markedly less often with vowel-initial disyllabic plurals than with their CC-initial counterparts.[8] So a plausible explanation of the gender split with respect to onset in this second experiment is that female subjects have a greater tendency to treat as vowel-initial the items that we had coded as sonorant-initial, and thus to insert /t/ less often with these, in the same way they would with uncontroversially vowel-initial plurals.

3.4 Sound plurals

As noted in section 3.1 and illustrated in Table 5, rates of /t/-insertion were not consistent across all the sound plural items tested. While 25 of the 49 items tested triggered no /t/-insertion at all, the other 24 did at least 5% of the time, and the item with the highest rate of /t/-insertion was *sferi* 'spheres' (sg. *sfera*), at 31%. We suspected before collecting the data that any such differences would be due to morphophonological properties of the plurals, specifically: 1) the nature of the first syllable (i.e. 'heavy', due to a long vowel or a word-medial geminate, and thus phonologically similar to the /t/-favouring broken-plural patterns, or otherwise 'light'), and 2) the position of stress (i.e. on the initial syllable, in the case of items with the plural suffixes *-i* and *-s*, or on the final syllable, in the case of items with the plural suffix *-iet*). Analysing the results with the same type of model described in section 3.2, this time with initial syllable weight and stress position as fixed effects, shows that only the former is a significant predictor of /t/-insertion rates (z = -2.755, p = 0.006). Specifically, while /t/-insertion was low or very low across the board with the sound plural items tested in this experiment, it was significantly less low with those items with a heavy initial syllable. This is illustrated in Figure 5.

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[8] The relevant disyllabic V-initial broken plurals tested in the first experiment had /t/-insertion rates ranging from 24%–25%, as compared with a range of 56%–80% for the disyllabic CC-initial broken plurals tested in that experiment.

Test items	Meaning	% /t/	Test items	Meaning	% /t/
sferi	spheres	*31%*	bramiet	jellyfish	0%
FJAMMI	flames	**22%**	**TNALJI**	tongs	**0%**
pjagi	plagues	*21%*	stensils	stencils	0%
friżers	freezers	*20%*	ħjariet	cucumbers	0%
bdoti	pilots	*17%*	qronfliet	carnations	0%
xkupi	brooms	*14%*	briksiet	bricks	0%
skedi	cards	*12%*	**PLATTI**	plates	**0%**
GRUPPI	groups	**11%**	drillers	drills	0%
stili	styles	*11%*	**TRAĊĊI**	traces	**0%**
travi	beams	*11%*	*gradi*	grades	*0%*
ŻBALJI	mistakes	**10%**	skandli	scandals	0%
pruniet	plums	9%	brimbiet	spiders	0%
DVALJI	tab. cloths	**7%**	blackboards	blackboards	0%
drogi	drugs	*7%*	*cruises*	cruises	*0%*
kwoti	shares	*6%*	*stejpils*	staples	*0%*
GRAMMI	grams	**6%**	**ĦNEJJIET**	arches	**0%**
ħġiġiet	panes	6%	spagiet	pcs of string	0%
SKOSSI	bumps	**5%**	ġbejniet	small cheeses	0%
skużi	excuses	*5%*	stampi	pictures	0%
flipflops	flipflops	5%	**VJAĠĠI**	journeys	**0%**
FROTTIET	fruits	**5%**	brackets	brackets	0%
slogans	slogans	*5%*	brushes	brushes	0%
spaners	spanners	5%	pjanti	plants	0%
DRAMMI	dramas	**5%**	statwi	statues	0%
kwadri	paintings	*0%*			

Table 5: CC-initial disyllabic sound plurals – test items and /t/-insertion rates

Key:

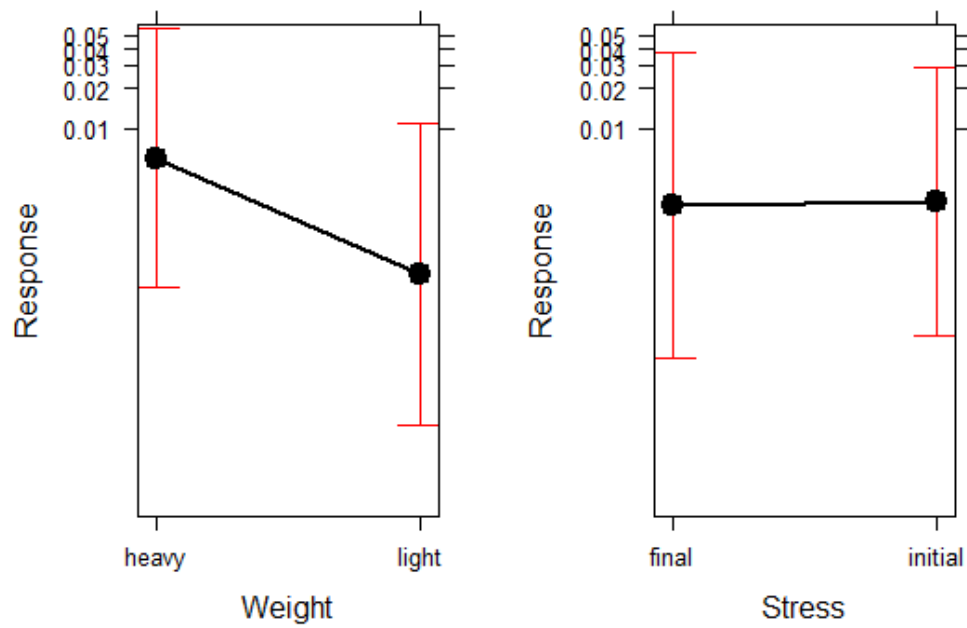|	
light first syllable:	plain typeface
heavy (long vowel):	*bold italics*
heavy (medial geminate):	**BOLD CAPS**

Figure 5: Plot of initial-syllable-weight and position-of-stress effects for sound plural data

3.5 Summary of results

In this new experiment on /t/-insertion behaviour with CC-initial disyllabic plurals we found, in line with our predictions, that broken plurals trigger /t/-insertion much more often than sound plurals, even when onset and number of syllables – the two factors generally cited in the previous literature as most significant to /t/-insertion – are held constant.

Also in line with our predictions was the finding that broken plurals of the *gwerer*-type CCVCVC pattern trigger /t/-insertion significantly less often than the other two CC-initial disyllabic broken plural patterns.

We suspected that the gender of our test subjects and the precise nature of the onset might have an influence on rates of /t/-insertion. This proved not to be the case, except that there was a significant interaction between gender and onset. This, we suggested, is best explained in terms of women leading a change in progress, whereby the prothetic vowel that may be inserted before words beginning with a SONORANT-CONSONANT cluster comes to be treated as part of the underlying representation of the word.

Finally, we suspected that /t/-insertion behaviour with sound plurals would be influenced by the weight of the initial syllable, and the position of stress, in the plural items tested. We found that items with a heavy initial syllable were associated with significantly higher rates of /t/-insertion than those with a light initial syllable, but that the position of stress was not a significant factor.

4 Discussion

We have seen that the two main predictions were borne out: when we hold onset and number of syllables constant (at CC and two, respectively), broken plurals are much more favourable to /t/-insertion than sound plurals, and broken plurals of the *gwerer*-type CCVCVC pattern are much less favourable than plurals of other patterns. This is clear confirmation that /t/-insertion cannot be understood purely in phonological terms such as the onset type and number of syllables of plural nouns: their morphological profile is at least as important.

As explained in section 2.1, the genesis of the hypothesis that *gwerer*-type CCVCVC plurals would be unfavourable to /t/-insertion, despite beginning with a consonant cluster, was the insight that they belong to the same basic (C)CVCVC pattern as plurals such as *bozoz* 'bulbs' (sg. *bozza*), which, like all CV-initial plurals, seem to be particularly hostile to /t/-insertion. If onset type had been more important, we would have expected *gwerer*-type plurals to pattern with other CC-initial broken plurals and be favourable to /t/-insertion. In the event, it was the morphological identity of these items – their membership of the /t/-resistant (C)CVCVC pattern – that proved decisive, not their onset.

We must be careful not to take this line of argument too far, however. Our results show that the kinds of phonological factors considered in the literature to date clearly cannot do all the work of explaining what governs /t/-insertion. But our results also indicate that

phonology has a role to play. This is perhaps easiest to see by considering the sound-plural items with the highest rates of /t/-insertion. These show that Borg's (1974: 297) blunt claim that "sound plurals do not take /t/" is too sweeping: they certainly do not favour /t/-insertion, but they do not rule it out altogether. Consider in particular items such as *pjagi* 'plagues' (sg. *pjaga*), with a /t/-insertion rate of 21%, and *travi* 'beams' (sg. *travu*) with a rate of 11%. These have an identical phonological profile to broken plural items we tested, such as *qsari* 'flower pots' (sg. *qasrija*), with a /t/-insertion rate of 87%, and *drabi* 'times' (sg. *darba*), with a rate of 67%. More generally, note the following parallels between the broken and sound plurals that we tested. The two broken plural patterns in our data that were more favourable to /t/ were CCVVCVC, as in *bramel* 'buckets' (sg. *barmil*), with a long vowel in the first syllable, and CCVjjVC, as in *knejjes* 'churches' (sg. *knisja*), with a medial geminate; and it was also the sound plurals with either a long vowel in the initial syllable or a medial geminate that triggered /t/-insertion significantly more frequently than the others. It is unlikely that this is a coincidence. Rather it seems that phonology is playing a secondary role here: an item's morphological identity as a sound plural ensures it will be basically hostile to /t/-insertion, but this hostility can be lessened to a limited extent, just in case its phonology closely resembles that of an appropriate broken plural pattern.

A similar dynamic seems to hold with the *gwerer*-type CCVCVC broken plurals. One might have expected these to be totally incompatible with /t/-insertion, rather than permitting it with an average frequency of 23%. After all, these have the same basic pattern as CV-initial plurals such as *bozoz*, which seem to totally exclude the possibility of /t/-insertion.[9] Instead it seems that, as with the sound plurals such as *sferi*, the morphological pressure on plurals such as *gwerer* to resist /t/-insertion is mitigated somewhat by their phonological similarity (having a CC onset) to the broken-plural patterns which actively favour /t/-insertion.

It is noteworthy, finally, that there is no main effect of gender on speakers' /t/-insertion behaviour (there is only the interaction with onset, which we suggest is a reflection of a wider gender split in the analysis of prothetic vs. underlying vowels, not an effect specific to /t/-insertion). With linguistic variation of this kind, where, in a sufficiently well-defined context (e.g. with broken plurals of the CCVVCV(C) type) there seems to be total optionality from a linguistic point of view, it is natural to expect that inter-speaker variation might be invested with social meaning. But this is especially likely to be the case with variation that is the result of changes in progress, and it could be that the optionality of /t/-insertion, at least in the restricted domain of disyllabic CC-initial plurals investigated here, is in fact a system that has been stable for several generations or more. Future studies could

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[9]
 A degree of caution is required here. In the first experiment, *bozoz*, which never triggered /t/-insertion, was the only plural of this type that we tested. Since a) it has never been suggested in the previous literature that /t/-insertion is possible with CV-initial items in general, and b) we found in our first experiment that CV-initial items, including other broken plurals such as *kotba* 'books' (sg. *ktieb*), were uniformly hostile to /t/-insertion, it is reasonable to extrapolate that this generalises to all broken plurals of the CVCVC pattern. But we do not, at present, have the data to prove that this is the case.

investigate this issue by repeating the kind of experiment described here, with test subjects stratified by age, gender, and perhaps other sociolinguistic variables.

5 Conclusion

This article has provided evidence that, contrary to previous work on the topic, it is morphological, not phonological properties of the plural noun that should be seen as the prime determinants of whether /t/-insertion is triggered in the presence of an accompanying numeral. Specifically, at least as far as CC-initial plurals are concerned, /t/-insertion is favoured only by particular broken-plural patterns. On the other hand, we have seen that phonology does seem to play a secondary role. While sound plurals are, on the whole, very hostile to /t/-insertion, there are some whose phonology happens to closely resemble that of the /t/-favouring broken-plural patterns, and it seems to be this which causes them to trigger /t/-insertion, if only rarely.

This is by no means all there is to be said on this topic. Aside from the sociolinguistic dimension suggested above, there are several aspects of the grammar of /t/-insertion that remain unclear, for example the conditions determining /t/-insertion with vowel-initial plurals, and whether the frequency of a plural noun (or a numeral–noun string) has an effect on its /t/-insertion behaviour. It is to be hoped that puzzles such as these can be solved in future work.

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