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Semantic transparency and doublet formation: the case of Hebrew location nouns

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Abstract
This study examines the correlation between derivational paradigms and morphological variation and change. I will examine a case study of Hebrew location nouns formation. Semitic morphology relies highly on non-concatenative morphology, where words are formed in patterns. Some Hebrew location nouns that are formed in one pattern, receive an additional form in another pattern with no change of their meaning. In contrast, there are location nouns, which are also formed in the same pattern, but do not have morphological doublets. Previous studies accounted for this change and proposed phonological and semantic criteria that trigger it. However, such explanation only account for why the change occurs, but not for cases where there is no doublet formation. I argue that morphological change is highly motivated in cases where the forms that undergo a change are part of a derivational paradigm. Specifically, I will show that only location nouns that are derivationally related to a verbal counterpart, such that the semantic relation between them is highly transparent, can undergo such change and have doublets. In contrast, words that are not part of such a paradigm are less likely to undergo change. The study highlights the important role of semantic transparency and derivational paradigms in morphological variation and change, showing that properties of words are not the only criteria that are taken into consideration, but also their relations with other words within a derivational paradigm.

Keywords Location nouns · Semantic transparency · Derivation · Derivational paradigms · Variation · Doublets

1 Introduction

This study examines the correlation between semantic transparency and morphological variation and change. I will examine a case study of Hebrew location nouns formation. Semitic morphology relies highly on non-concatenative morphology, where

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words are formed in patterns. As shown in (1) below, some Hebrew location nouns receive an additional form with no change of their meaning.

(1) Hebrew alternating location nouns

mispara ∼ maspera	'barber shop'
mixbasa ∼ maxbesa	'laundromat'
mišxata ∼ mašxeta	'slaughterhouse'

The location nouns in the left column in (1) are all formed in the *miCCaCa* pattern, which is more typical of location nouns. This pattern is also considered the prescriptive form of such nouns. However, they all have colloquial doublets in the *maCCeCa* pattern, which is typical of instrument nouns, as shown in the right column in (1).[1] The term 'doublets' is used here to denote words with different form but the same meaning (see 2.3).

The two forms in each pair in (1) can be used interchangeably in the same semantic-syntactic contexts (Bolozky 1999a, 2003, Gadish, 2000). In contrast, there are location nouns, which are also formed in the same *miCCaCa* pattern, but do not have colloquial doublets in *maCCeCa* (2).

(2) Hebrew non-alternating location nouns

mixlala ∼ *maxlela	'college'
mifkada ∼ *mafkeda	'headquarters'
minhara ∼ *manhera	'tunnel'

Why do some location nouns have doublets, while others do not? I argue that doublet formation is highly motivated in cases where the forms that undergo a change are part of a derivational paradigm. Specifically, I will show that only location nouns that are derivationally related to a verbal counterpart, such that the semantic relation between them is highly transparent, can undergo such change and have doublets. In contrast, words that are not part of such a paradigm are less likely to undergo change. The study highlights the important role of derivational paradigms in morphological variation and change, showing that properties of words are not the only criteria that are taken into consideration, but also their relations with other words within a derivational paradigm. The study also highlights the strong correlation between semantic properties and morpho-phonological processes, as has already been demonstrated in other cases studies (see for example Plag, 2006; Plag et al., 2008).

Some of the examples in this study are of doublets that coexist in the language, while others are instances of diachronic change, where one form has ceased to be used, as least colloquially. The study does not make a distinction between such cases. The claim made here is that synchrony and diachrony are organized according to the same principles. Examples of change across a range of times and situations seem to obey similar constraints, supporting the idea that there are systematic principles governing preferred directions of change.[2]

[1] The term 'prescriptive' is used here to denote the formal citation forms that can be found in dictionaries and in grammar books and that tend to be used in more formal contexts. Colloquial forms are more common in everyday speech and in less formal contexts in general.

[2] I would like to thank an anonymous reviewer who pointed it out to me.

This paper is organized as follows. Section 2 provides background on word formation in Hebrew, focusing on location nouns and on non-concatenative formation. Section 3 accounts for cases of doublet formation (and lack thereof) within location nouns. It presents some generalizations about this change and previous accounts for it. It then turns to a comparison between location nouns that undergo change, and others that do not. This is accounted for by examining the derivational relations between location nouns and their verbal counterparts, and the degree of semantic transparency between them. Section 4 presents an experiment that provides evidence to the account in 3, showing the degree of variation of such location nouns (and lack thereof). It is claimed that it is possible to provide predictions about location nouns that are and are not likely to undergo morphological change, based on the degree of semantic transparency within a derivational relation. The more transparent and systematic the relation is, the greater the likelihood of doublet formation. Section 5 draws conclusions in terms of the implications of the study with regard to the predictability of morphological variation and change, the central role of derivational relations and semantic transparaency, and the interaction between morpho-phonological and semantic relations.

2 Hebrew word formation

2.1 Non-concatenative morphology

Word formation in Hebrew relies highly on non-concatenative morphology (Ornan 1983, 2003, Berman 1978, 1987, Bolozky, 1978, Schwarzwald 1981, 2002, Goldenberg 1998, Ravid, 1990; Aronoff, 1994; Bat-El, 1994a; Benmamoun, 2003; Ussishkin, 1999, among many others). Verbs alone *must* invariably be formed via non-concatenative morphology. The Hebrew verbal system consists of patterns. The pattern indicates the prosodic structure of verbs, their vocalic patterns and their affixes (if any) (Bat-El, 2011). Every new verb that enters the language must conform to one of the existing patterns.[3] Examples of some verbal patterns are listed in (3), illustrated by verbs in the morphologically simplest form of past tense, 3rd person masculine singular.

(3) Hebrew verbal patterns[4]

Pattern	Gloss	
CaCaC	katav	'write'
hiCCiC	himšix	'continue'
CiCeC	limed	'teach'

Noun formation in Hebrew is in general more varied in its formation strategies in comparison to verb formation. Nouns can be formed in patterns, but are also formed

[3] Some patterns consist of affixes as well, and prefixes and suffixes are used for inflection, but verb formation always requires at least one kind of non-concatenative element.

[4] The examples in this study are in their past form, which is the citation form, conventionally assumed to be the base of formation throughout the inflectional paradigm, as it is free of inflectional suffixes (see Ussishkin, 1999 and Bat-El, 2002, among others). However, the direction of derivation is irrelevant for the purposes of my analysis.

by affixation and other word formation strategies (4). For example, agent nouns can be formed in patterns like *CaCaC*, e.g. *cayar* 'painter', or by suffixation, e.g. *psanter* 'piano' - *psantr-an* 'pianist', as well as by other strategies.[5] While there are only 5 verbal patterns, there are between 30-35 nominal and adjectival patterns, that differ from each other in productivity and meaning. Below are some examples of Hebrew nominal patterns that have typical meanings (4).

(4) Hebrew nominal patterns

Pattern	Typical meaning	Example	
CaCaC	agent nouns	nagan	'player'
CCiCa	action nouns	ktiva	'writing'
maCCeC	instrument nouns	mazleg	'fork'
CaCeCet	diseases	xazeret	'mumps'

It is important to note that the meaning of Hebrew patterns reflect tendencies, rather than one-to-one relations. Some patterns host nouns with typical meaning, while other host a variety of types of nouns, but none of the pattern has exclusive meaning (see Berman, 1978, Bolozky, 1999a,b, Schwarzwald, 2002, Ravid 1999, 2004, 2006, Schwarzwald 2002, 2009, Berman & Seroussi, 2011, Shatil 2014, 2015, among many others).

2.2 Hebrew location nouns

Location nouns exist cross linguistically and are derived in various word formation strategies. In some languages they are marked with specific affixes that are typical of locations, while in other the affixes that mark locations have a more general semantic function (Bauer, 2011). Hebrew location nouns are formed by several word formation processes. The suffix *-iya* is highly productive and is agglutinated to nouns and forms location nouns, e.g. *nagar* 'carpenter' – *nagariya* 'carpenter workshop' (see Berman, 1987; Bolozky, 1999a, among others).

This study examines only location nouns that are formed in patterns. There are two main patterns that are used for such nouns, *miCCaC* (e.g. *misrad* 'office') and *miCCaCa* (e.g. *mixlala* 'college'). Bolozky (1999a, 2003), shows that the location noun patterns have relatively low semantic transparency, as they can host different types of nouns, which do not denote locations. *miCCaC* is less transparent than *miCCaCa*, as only about 25% of its nouns denote location, while about 80% of the *miCCaCa* nouns denote location (Bolozky, 1999a). As shown below, each of the patterns can host location nouns (5a), as well as other nouns that do not denote locations (5b).

[5]Nouns, unlike verbs, can also be borrowed directly from other languages without regard to templatic structure (see for example, Ravid, 1992; Schwarzwald, 1998 and references therein).

(5) Location noun patterns

miCCaC		miCCaCa	
a. location nouns			
migraš	'court yard'	mirpaʔa	'clinic'
miklat	'shelter'	mispara	'barber shop'
mitbax	'kitchen'	mitpara	'sewing workshop'
mikdaš	'temple'	misʔada	'restaurant'
b. other nouns			
mixtav	'letter'	mimxata	'handkerchief'
mifgaš	'meeting'	mitkafa	'attack'
migvan	'variety'	mikdama	'payment'
mimšal	'regime'	mignana	'defense'

Hebrew instrument nouns are also formed in two dominant patterns, *maCCeC* (e.g. *masrek* 'comb') and *maCCeCa* (e.g. *maclema* 'camera'). In contrast to the location noun patterns, the semantic transparency of instrument noun patterns is relatively higher (see, Berman et al., 1982; Bolozky, 1999a). As shown in (6a), these two patterns are highly typical of instrument nouns, and examples of other nouns are quite rare (6b).

(6) Instrument noun patterns

maCCeC		maCCeCa	
a. instrument nouns			
masrek	'comb'	maclema	'camera'
masnen	'filter'	masxeta	'juicer'
mazleg	'fork'	magrefa	'rake'
makren	'projector'	mamtera	'water sprinkler'
b. other nouns			
martef	'basement'	mahpexa	'revolution'

The two location nouns patterns, *miCCaC* and *miCCaCa*, are semantically less transparent in comparison to the two instrument noun patterns *maCCeC* and *maCCeCa*. I will return to this point in the following section.

3 Doublet formation of Hebrew location nouns

3.1 The change

Some location nouns undergo morphological change and receive an additional form in the pattern with no change in their meaning (7).

(7) Alternating location nouns

mispara ∼ maspera 'barber shop'
mixbasa ∼ maxbesa 'laundromat'
mišxata ∼ mašxeta 'slaughterhouse'

Two immediate generalizations regarding this change are in order. First, the change is always from the *miCCaCa* pattern, which is typical of locations, into the *maCCeCa* pattern, which is typical of instruments, and never the other way around. *maCCeCa* nouns do not change into *miCCaCa* (e.g. *maclema* ∼ **miclama* 'camera'). Second, *miCCaC* location nouns do not have doublets in the instrument noun pattern

maCCeC. For example, the location noun *migraš* 'courtyard' does not have a doublet like **magreš* (*maCCeC*).

As noted in Sect. 1, some of these doublets coexist in the language, while others are instances of diachronic change.[6] Such cases of variation are also found in spoken Hebrew in recordings from the fifties and sixties, as shown by Gonen and Reshef (2018). As noted is the introduction, this study does not make a distinction between such cases. The claim is that the preference for *maCCeCa* is systematically triggered by the same factors. I now turn to account for this doublet formation.

3.2 Morphological variation and doublets formation

Variation is inherent in human languages and is crucial to the study of the language faculty. Different speakers can express the same meaning using different forms, but also the same speaker can use different forms for the same meaning. Morphological variation is also known as "overabundance" or "polymorphy", where a cell within a paradigm can be filled by more than one form (Anttila 1997, 2007). The forms that fill the same cell are labeled "doublets", i.e. words with different form but the same meaning (see for example, Bloch, 1971; Aronoff, 1976, Malkiel 1977, Kroch 1989, Taylor 1994, Acquaviva 2008, Embick, 2008, Corbett 2010, Dal & Namer, 2010; Mörth & Dressler, 2014; Fradin, 2016), or "cell-mates" (2011, Thornton, 2012a,b). The two (or more) forms are in competition, as they can in principle be used in the same syntactic and semantic contexts. Competing forms within a single morphological slot deviate from canonicity, as defined in Corbett (2005), and pose a challenge for models that aim to explain why and how speakers select one form and not another. Linguistic variation often results from a change that languages undergo at some point and whose result becomes established in the grammar. The issue of linguistic variation and change has been addressed by linguists since the 19th century, following Neogrammarian accounts of sound change (Bloomfield 1933, Hinskens et al. 1997). Various studies have associated variation and change with the speaker's competence and considered variation an inherent part of natural language. The study of linguistic change and competition from a synchronic point of view can contribute to linguistic theory by providing a unique perspective on the properties involved in a particular grammatical phenomenon and of the interrelations between them (Macken, 1992). Moreover, variation in speakers' productions reflects speaker competence and so can be taken to represent the grammar (Adam, 2002). Variation has been addressed with regard to inflectional paradigmatic relations, where a canonical paradigm is expected to exhibit uniqueness of realization, such that for every stem, each cell in its paradigm must be filled in a unique way (Carstairs 1987, Stump 2001, 2010, Corbett 2005, 2007, Stump and Finkel 2013 among others). Deviations from canonical paradigms are represented by variation, where a cell is filled by two (or more) synonymous forms (Thornton 2011, 2012a). Variation is also associated with competition for grammaticality and use under certain approaches. On these views, the grammar generates numerous structures or words that express the same meaning and includes a mechanism

[6] In some dictionaries (e.g. the Hebrew Sapphire Dictionary, Avenyon, 1997), some of the *maCCeCa* forms are marked as ungrammatical.

for selecting one winner, marking the rest as ungrammatical (Embick, 2008). This means that if one variant is employed, another is not (see also Rainer, 1988; Joseph, 1998; Plag, 2000; Bauer, 2006; Kiparsky, 2010). This in turn leads naturally to the idea that distinct variants are competing with one another in the grammar (Weinreich et al., 1968; Pintzuk, 1991; Yang, 2002). Nevertheless, in some cases more than one competitor is selected as grammatical, with these variants in competition for surface use. Thornton's (2011, 2012a) case studies of cell-mates refers to cases of competing inflectional forms that demonstrate complete synonymy. This is typical mainly for inflection, as inflectional categories are determined by the morpho-syntax (Stump, 2016; Aronoff, 2017) and rival inflectional patterns are unable to differentiate themselves in their denotation. The picture is different with respect to competition between derivational processes and patterns. Aronoff (2016, 2017) shows that competing derivational affixes are less likely to be in real competition. Since there are no necessary paradigm cells to fill in derivation, in contrast to inflection, it is impossible to count how many inputs or outputs there are for a given morphological process. Furthermore, semantic and pragmatic factors allow competing derivational patterns to differentiate themselves in many ways, where each pattern can have its own niche. Aronoff shows that a great deal of similarity exists between competing derivational affixes and ecological niche differentiation, in which natural selection drives competing species into different distribution patterns of resource use.

The present analysis considers morphological variation in the formation of Hebrew location nouns, which is the result of change. It will demonstrate that such change, as well as lack thereof, is not random, and can be predicted based on systematic guidelines, so that it can be expressed within a model of the speaker's knowledge.

3.3 Why do Hebrew location nouns undergo a change?

Examining cases of doublets like *mispara* ~ *maspera* 'barber shop' raises questions with regard to what motivates this change. The reasons for it have been addressed in previous studies by Bolozky (1999a, 2003), who proposed two main reasons. From the phonological point of view, Bolozky argues that it has to do with the fact that the vowel *a* is less marked in comparison to *i* and hence it is preferred as a prefix. As a result, the *maCCeCa* pattern is preferred over *miCCaCa* as the former begins with *a*. It is important to note that the change here is not only from *i* to *a*, but to a different pattern, where the second vowels changes from *a* to *e*. A possible change of location nouns like *maspera* could have been into **maspara*. However, Hebrew words that are formed via non-concatenative morphology have to conform with one of the existing patterns. Patterns like *maCCaCa* do not exist in Hebrew and therefore the change is into the most similar pattern that begins with the unmarked vowel *a*.[7] On the semantic dimension, Bolozky claims that the *miCCaCa* and *miCCaC* patterns are less transparent than the *maCCeCa* and *maCCeC* pattern, which are used mainly for the formation of instrument nouns (see 2.2). He argues that the shift is into a pattern that is semantically more transparent, so that the *maCCeCa* pattern has become a

[7] Bolozky (2003) also mentions the orthographic resemblance between the location and instrument patterns as one of the factors that trigger the change.

default pattern for both location and instrument noun formation. The change from *miCCaCa* into *maCCeCa*, according to Bolozky, is motivated both by phonological and semantic criteria. According to Bolozky's account, it is predicted that all location nouns of the *miCCaCa* pattern would have *maCCeCa* doublets. However, this is not the case. As shown in (8) below, and as will be shown via an experiment (Sect. 4), some *miCCaCa* location nouns have no doublets. Taking on Bolozky's account of sematic transparency, the current study explains why doublet formation occurs with only some of the location nouns.

In addition, some studies have revealed a noticeable tendency for polysemy of location and instrument nouns in different languages (Bauer, 2000; Rainer, 2011; Luschützky & Rainer, 2013). Meyer-Lübke (1894), as cited in Luschützky and Rainer (2013), claims that the place where an action is performed or occurs, can also be conceptualized as the means by which it is carried (see also Namer & Villoing, 2008). Luschützky and Rainer (2013) examine this tendency is a sample of more than 100 languages. They show that there is an extensive cross-linguistic tendency and propose different possible sources for it. This typological tendency could as well motivate the unification of the location and instrument nouns in the same pattern.

However, the questions that this study addresses are different. While some location nouns undergo such change, others do not (8).

(8) Non-alternating miCCaCa location nouns

midša?a ~ *madše?a	'lawn'
mizbala ~ *mazbela	'garbage dump'
mixlala ~ *maxlela	'college'
mifkada ~ *mafkeda	'headquarter'

All the *miCCaCa* nouns in (8) denote locations, but they retain their pattern and do not have doublets in *maCCeCa*. For example, *mixlala* 'college' does not alternate with **maxlela*. According to the phonological and semantic criteria proposed by Bolozky, as well as the tendency for polysemy in instrument and location nouns, we would expect the nouns in (8) to undergo change as well. Why then, do only some location nouns undergo variation?

In addition, according to Bolozky's account for the *miCCaCa* → *maCCeCa* change, we would also expect a *miCCaC* → *maCCeC* change of locations nouns. In fact, such a change would have even greater motivation as the *miCCaC* pattern is less typical of location nouns in comparison to *miCCaCa* (see 2.2). Since *miCCaC* is even less semantically transparent, we would expect its location nouns to shift into a more transparent pattern. However, as shown in (9), all *miCCaC* location nouns retain their form and have no doublets in *maCCeC*.

(9) Non-alternating miCCaC location nouns

migraš ~ * magreš	'lawn'
minzar ~ * manzer	'monastery'
misrad ~ *masred	'office'
mikdaš ~ * makdeš	'temple'

I therefore raise two questions: (i) why do some *miCCaCa* nouns undergo a change while others do not? and (ii) why none of *miCCaC* nouns undergo change?

I will address both questions together and I argue that the existence of variation and change relies on paradigmatic relations between a location noun and a verbal counterpart and their semantic relations. It is based on the semantic relation between a location noun and a corresponding verb. Specifically, only location nouns that are part of a verb-noun derivational paradigm, where the semantic relation is transparent, can undergo such a change.

All the alternating locations nouns in (10) are related to a verbal counterpart in the sense that the typical action that takes place in these noun is the one denoted by the corresponding verb. For example, *mispara/maspera* 'barber shop' is related to the verb *siper* 'cut hair' as the typical action that takes place there is cutting people's hair. Similarly, *mitpara/matpera* is a typical place in which the action of sewing is performed. This does not mean of course, that the event that the verb denotes does not take place in other places, but that the typical event that takes place in such locations is the one denoted by the verb. Pairs like *siper-mispara* (and *maspera*) and *tafar-mitpara* stand in a morphological relation and therefore form derivational paradigms. The semantic relations between members of such paradigm are highly transparent, as the location noun typically denotes to location of the action that the verb denotes.

(10) Alternating miCCaCa location nouns[8]

Location noun		**Corresponding verb**	
mispara ~ maspera	'barber shop'	siper	'cut hair'
mixbasa ~ maxbesa	'laundromat'	kibes	'launder'
mišxata ~ mašxeta	'slaughterhouse'	šaxat	'slaughter'
mitpara ~ matpera	'sewing workshop'	tafar	'sew'

In contrast, *miCCaCa* location nouns that are not related to any verb do not have *maCCeCa* doublets. The noun *midša?a* 'lawn', for example, is not related to any verb. There is no need to mark this location noun as part of a derivational paradigm. In addition, there are cases where the location noun and the verb share the same consonantal root, but there is no semantic relation between them, or the semantic relation between them is not transparent. *mixlala* 'college', for example, could be historically related to the verb *kalal* 'include' or *hixlil* 'generalize', but there is no synchronic relation between them.[9] *mifkada* 'headquarters' is semantically related to the verbs *piked* 'command' and *pakad* 'order', but the semantic relation is not transparent; headquarters is not necessarily the place where one commands/orders. More such examples are presented in (11).

[8] In some cases there are stop~fricative alternations within the stem consonants, e.g. *tafar* 'sew' – *mitpara* 'sewing workshop'. Such alternations are irrelevant for the purposes of the current study.

[9] The claim that location nouns like *mixlala* 'college' and verbs with the same root like *kalal* 'include' or *hixlil* 'generalize' do not form a derivational paradigm, as there is no derivational relation between them, does not necessarily mean that nouns like *mixlala* are morphologically simplex. Such nouns consist of root and pattern and are morphologically more complex than noun with no morphological structure (e.g. et 'pen'). The issue of morphological complexity is beyond the scope of this paper. I thank an anonymous reviewer for raising this issue, which required further clarification.

(11) Non-alternating miCCaCa location nouns

Location noun		Corresponding verb		Semantic relation
midša?a ~ *madše?a	'lawn'	---------		None
ninhara ~ *manhera	'tunnel'	nahar	'flow (people)'	None
mixlala ~ *maxlela	'college'	kalal/hixlil	'include'/'generalize'	None
mifkada ~ *mafkeda	'headquarter'	pakad piked	'order' 'command (a team)'	Less transparent
midraxa ~ *madrexa	sidewalk	darax	'step'	Less transparent

Even in cases where the location noun denotes the location where the action of the verb is performed, the location noun has to be a typical location, so that the semantic relation is transparent. For example, the location noun *midraxa* 'sidewalk' is semantically related to the verb *darax* 'step'. However, the typical location of stepping is not necessarily a sidewalk, and this location is not intended only for stepping.

Why then, do only location nouns with transparent relation to verbs have doublets? The change from *miCCaCa* into *maCCeCa*, and specifically, the change into a pattern that begins with *a*, marks the location noun as part of a derivational paradigm and as related to a verb. The tendency to select a pattern that begins with *a* is not surprising. In general, *a* has a morpho-lexical status in Hebrew. It is the most frequent vowel in word formation processes (Plada, 1959; Bolozky & Becker, 2006) and it is part of various word formation processes. Bolozky (1999a, 2003), Schwarzwald (2002, 2012) and Schwarzwald and Cohen-Gross (2000) show that *a* is the most common vowel in Hebrew patterns, and Bat-El (1994b) and Bolozky (1999b) show that it is the default vowel in acronym formation. Assuming that derivation of location nouns applies in the lexicon, the morphological mechanism marks location nouns as derivationally related to verbs using a pattern with a typical vowel that is used in derivation.

The above proposal also accounts for the lack of variation in *miCCaC* location nouns. Recall that such nouns do not have doublets in the *maCCeC* pattern that is used mostly for the formation of instrument nouns (e.g. *mazleg* 'fork'). Such doublet formation is expected to take place based on Bolozky's account for *miCCaCa* locations nouns. Why do *miCCaC* location noun retain their form? To begin with, only about 25% *miCCaC* nouns denote locations (see 2.2). Within the nouns that do denote locations, and similarly to *miCCaCa* non-alternating nouns, *miCCaC* location nouns are not related to the verbal system and do not form verb-location noun derivational paradigms. In some cases, there is no verbal counterpart at all (e.g. *misrad* 'office'), or the semantic relation between the location noun and the verb is relatively vague and not transparent For example, *mitbax* 'kitchen' could be historically related to the verb *tavax* 'slaughter', but synchronically, the relation is vague. Since these location nouns are not part of a derivational paradigm, there is no trigger to change their form and mark them with a vowel as derivationally related to verbs, and therefore doublet formation does not take place.

In addition to the non-alternating *miCCaC* and *miCCaCa* location nouns, the two patterns, and especially *miCCaC*, host other types of nouns (e.g. *migvan* 'variety', *mitkafa* 'attack'). Some of these nouns are not related to verbal counterparts, for example, *min?ad* '(music) range' and *mišpaxa* 'family'. Such nouns are indeed not expected to have doublets. In contrast, other nouns have verbal counterparts, which are related to them. For example, the *miCCaCa* noun *mignana* 'defense' is related to the verb *hegen*/*gonen* 'defend', denoting the state/result of defending. The *miCCaC*

noun *mivxan* 'exam' is semantically related to the verb *baxan* 'examine'. As there is a semantic relation between such nouns and their verbal counterparts, one could expect them to undergo a morphological change that would mark them as derivationally related to verbs. However, none of them have doublets. Why is it so? I argue that while there is a semantic relation between such pairs of nouns and verbs, the relation is not systematic and therefore less transparent and less predictable. The *miCCaC*/*miCCaCa* nouns that are related to verbs and are not location nouns cannot be classified according to a specific type of semantic relation with their verbal counterparts. Some denote the result of the action that the verbs denote, some denote states, and other denote tools/instruments as well as abstract nouns. In contrast to the verbs and location nouns pairs, where the semantic relation is straightforward, such that the location noun denotes the location of the action of the verb, these non-location nouns do not establish consistent derivational paradigms.

The picture that emerges is that there are several conditions for *miCCaCa* (and *miCCaC*) to undergo a morphological change. Such nouns have to (i) denote locations; (ii) be related to a verb; and (iii) the semantic relation between the noun and the verb has to be highly transparent and systematic.[10] These generalizations echo previous studies of variation in Hebrew instrument and agent nouns (see Author 2015, 2017, Gadish, 2016) that tend to shift into participle templates, which are also used as the present tense forms of verbs. While such alternations do not take place across the board, when they do occur they seems to follow systematic guidelines. Instrument and agent nouns change into participle patterns only when they are related to verbs, and even in such cases, doublet formation occurs only when the semantic relation is transparent. This change is motivated by both morphological and semantic transparency between verbs and instrument/agent nouns. Their motivation is different form to motivation for the change of location nouns, but in all cases it is highly dictated by the degree of semantic transparency between words and their being part of a derivational paradigm. Many studies highlight the importance of semantic transparency, which in general has been shown to play an important role in morphology (see Aronoff 1976, 2017, Spencer, 1991; Anderson, 1992; Baayen, 1993; Zwitserlood, 1994; Libben et al., 2003; Plag, 2003; Rainer, 2005; Giegerich, 2006. Plag et al. 2007, 2008, among others).

3.4 The role of paradigms in derivational relations

The above account for doublet formation and lack thereof provides support for the important role of paradigms in morphology, and specifically in derivation and not only inflection. Various studies have shown that there is access to an entire paradigm during the course of inflection and the application of morpho-phonological processes

[10] As noted by an anonymous reviewer, many of the location nouns discussed in the paper, as well as others, are semantically and morphologically related to other nouns with the same consonantal root, e.g. *mištara* 'police ~ police-station ~ police-force' and *šoter*. However, the relation between location nouns and other nous is less regular in contrast to the relation between location nouns and verbs. For example, the relation between *midša?241a* 'grassy area, lawn' and *deše* 'grass, lawn' is not the same as the relation between *mištara* 'police ~ police-station ~ police-force' and *šoter* 'policeman'. Such pairs do not represent regular and transparent paradigms and as a result there is no motivation for doublet formation. I thank the reviewer for this important observation.

(Steriade 1988, 2000, McCarthy, 2005). As a result of the connections between items within paradigms, there are various cases where a phonologically motivated alternation is suppressed in favor of paradigm uniformity. Thus, relationships within words are taken into account during word formation. This study provides further support for the claim that the mechanism of word formation takes into account not only the word itself but also its relationships to other words in a paradigm (van Marle, 1985; Spencer, 1988; Corbin, 1989, Stump 1991, 2016, Anderson, 1992; Bochner, 1993, Booij 1995, 2008, Blevins, 2006 and references therein). This process is called paradigm leveling, where one (or more) forms in a paradigm become identical in one or more features to other members in the paradigm in order to achieve paradigm uniformity. Such paradigm leveling (Kenstowicz, 1996; Steriade, 2000; Albright, 2005) may be towards the isolated form that has no inflectional affixes, the most frequent form or unmarked form (Paul 1891, Kuryłowicz 1949, Mańczak 1958, Bybee, 1985), or a form preserving the most phonemic contrasts (Albright 2002, 2006). In general, paradigm leveling lends support to Correspondence Theory (McCarthy and Prince 1995) that accounts for relations between related forms, and specifically to the concept of output-output correspondence (see Bat-El, 1994a; Benua, 1997; Raffelsiefen, 1995; Kenstowicz, 1996; Burzio, 1998; Ussishkin, 2005; Blevins, 2006, among others). The latter requires that the surface forms of the paradigm have certain identical features, even if this means violating other constraints in the system. This could either be achieved by a certain base (or several bases) against which all members of the paradigm are evaluated (Benua, 1997; Burzio, 1998, Steriade 1999, Bat-El, 2005; Albright, 2008), or by all members of the paradigm influencing all the other members of the paradigm (Kenstowicz, 1996; McCarthy, 2005), without assuming a specific base. The morphological component in the grammar is required to examine all forms in a paradigm and aims at inter-paradigm uniformity (see Faust, 2005; Pariente, 2012, Zadok & Bat-El 2015). This ensures that the relation between the forms is transparent.

The paradigmatic approach has been gaining a growing in derivational morphology, in addition to its well-established role in inflection. Many studies demonstrate the importance of paradigms in word formation (see for example, Bauer, 1997; Pounder, 2000, Booij 1997, 2010, Beecher, 2004; Booij & Lieber, 2004, Hathout and Namer 2014, 2019, 2022, Štekauer, 2014; Bonami & Strnadová, 2019, Roché & Plénat 2015, Blevins, 2016, among others).

The current study shows that there is also relation between inter-paradigm uniformity and doublet formation. It is important to clarify that the term 'paradigms' is used in this study in a general sense. I assume that words are organized in the lexicon in term of paradigms, regardless of whether or it is clear what the base is or if there is a base. This is a general view of how words are (assumed to be) stored and organized in the lexicon, and what the types of the relations between them are. Specifically for this case study, I assume that the verb is the base and the location noun is derived from it (for independent reasons, both morphological and semantic ones), but this is actually not crucial for the proposed analysis. What matters is that there is a derivational relation between the two words, and the more transparent it is, doublet formation is more likely to occur. As shown, doublet formation is attested only when a location noun is a part of a semantically transparent derivational paradigm. Restricting this change

to such cases results in uniformity with the verb-to-noun paradigms and makes them distinct from nouns that are either not part of a derivational paradigm. Nouns that are part of such paradigms are morphologically marked in a uniform way and this makes the paradigm distinct form other paradigms (and words). Such uniformity also establishes greater predictability with the derivational paradigm, such that the shape of one member of a paradigm could be predicted based on another member and the relations between them (see Haspelmath & Sims, 2010; Ackerman & Malouf, 2013; Stump & Finkel, 2013; Bonami & Beniamine, 2016, for discussion of the predictability of forms in inflectional paradigms).

3.5 Interim summary

The existence of morphological variation in location nouns also depends on the paradigmatic relations between location nouns and verbs and the degree of semantic transparency. This explanation captures the difference between alternating and non-alternating location nouns, in addition to Bolozky's (1999a, 2003) phonological and semantic criteria discussed in 2.2.

In order to provide empirical evidence to the claims made above, I conducted an experiment that examines the degree of variation in *miCCaCa* nouns. I now turn to present the experiment and its results.

4 Variation of location noun patterns – experiment

4.1 Research goals

The goal of this experiment was to identify and quantify variation of location nouns of the *miCCaCa* pattern. The study examines speakers' tendencies to use *miCCaCa* or *maCCeCa*.

4.2 Methodology

Speakers' preferences were tested in an experiment, where 50 participants, aged 18-42 (26 women, 24 men) read sentences aloud. All the participants were native speakers of Hebrew with medium/high socio-economic status and had at least 12 years of education. The experiment contained 19 sentences with location nouns of the *miCCaCa/maCCeCa* forms. Hebrew texts are typically unvoweled so Hebrew orthography does not distinguish between *miCCaCa* and *maCCeCa*. This enabled to present the words to participants and examine how they would pronounce them.[11] Participants were not forced by graphematics to read the nouns filling the vocalic slots with a pre-specified pattern, and therefore were free to make use of a different one with regard to the pattern which is required by the norm. Each sentence was separated by at least two filler sentences that did not contain any location nouns. The order of presentation was the same for all participants. The items were distributed in a way

[11] Some of the recordings were collected by Arba (2017).

that location nouns with the same (or similar) degree of semantic transparency are not presented one after the other, and are scattered throughout the experiment. Participants were asked to read the sentences aloud and then indicate after every sentence whether it had a positive, negative or neutral connotation. This was done in order to veil the research question, making the participant focus on the content rather than the form. Participants were recorded and the items were classified according to the location noun pattern that was selected, *miCCaCa* or *maCCeCa*. The study was approved by the review board of the Faculty of Humanities, Bar-Ilan University.

The location nouns were classified with respect to the semantic relation between them and their verbal counterparts (if any). The location nouns that are related to verbs, were rated according to the level of semantic transparency between the verb and the location noun. In order to determine the degree of semantic transparency (and lack thereof), another experiment was conducted, in which participants were presented with locations nouns were asked to say the most typical action that people do in these locations (see Appendix B). It is important to note that is some cases it was not entirely clear whether there is a related verbs and if the relation is synchronically opaque. As discussed in 3.3, and as will also be shown in the results, the relevant contrast is between location nouns with high semantic transparency, and between all the other items, namely those with low semantic transparency or without verbal counterparts at all. In addition, the locations nouns were classified by frequency, which is based on a database of the Hebrew phonological lexicon (Gafni, 2019).[12]

4.3 Hypothesis

Based on the above analysis, it is assumed that:

(i) Location nouns that are related to verbs with high semantic transparency will be more likely pronounced as *maCCeCa*.

(ii) Location nouns that are not related to verbs or with low semantic transparency between them and the verbs, will be more likely pronounced as *miCCaCa*.

(iii) Location nouns that are related to verbs, but with medium semantic transparency are more likely to demonstrate greater variation between the two patterns.

4.4 Results

The results per item are presented in (12), starting with items that were mostly pronounced as *miCCaCa*, and followed by items that were mostly pronounced as *maCCeCa*.

[12]The lexicon was generated based on several plain-text corpora from MILA (http://mila.cs.technion.ac.il/resources_corpora.html) and includes entries that have available phonetic transcription. See https://chengafni.wordpress.com/resources/heblex/.

(12) miCCaCa / maCCeCa selection[13]

Location noun		Related verb yes/no	Log Lexical Frequency	Semantic transparency rating %	miCCaCa		maCCeCa	
					num.	per.	num.	per.
mixlala	'college'	no	1618	0%	49	100%	0	0%
minhara	'tunnel'	no	436	0%	50	100%	0	0%
midraša	'college'	no	239	0%	48	96%	2	4%
midša?a	'lawn'	no	0	0%	47	96%	2	4%
mizbala	'garbage dump'	yes	15	14%	37	74%	13	26%
minhala	'administration'	yes	533	19%	50	100%	0	0%
midraxa	'sidewalk'	yes	151	25%	50	100%	0	0%
mizlala	'fast food restaurant'	yes	14	25%	42	84%	8	16%
mifkada	'headquarters'	yes	483	28%	50	100%	0	0%
mirpa?a	'clinic'	yes	262	31%	33	66%	17	34%
maxšeša	'hashish den'	yes	14	31%	2	4%	48	96%
mištala	'gardening nursery'	yes	43	44%	24	48%	26	52%
mixla?a	'enclosure'	yes	43	64%	44	90%	5	10%
mištana	'urinal'	yes	65	86%	12	24%	38	76%
mixbasa	'laundromat'	yes	0	86%	2	4%	47	96%
mitpara	'sewing workshop'	yes	7	89%	9	18%	40	82%
mišxata	'slaughter house'	yes	7	92%	5	10%	43	90%
mispara	'barber shop'	yes	121	94%	11	22%	39	78%
maxceva	'quarry'	yes	191	94%	1	2%	49	98%

A mixed-effects logistic regression model was constructed to analyze participants' selections, coded as 0=miCCaCa vs. 1=maCCeca. The model incorporated random intercepts for Participant and Item variables. Two continuous variables, Log Lexeme Frequency (LogLexFreq), and Semantic Transparency (SemTranspRating), were included as predictors. The outcomes of the model are presented in (13). The model revealed no significant effect of frequency; however, it exhibited robust effect of semantic transparency (see also Fig. 1).[14]

(13) Results for the mixed-effects logistic regression model for Selection of miCCaCa vs. maCCeCa

Model: glmer(Selection ~ LogLexFreq + SemTranspRating + (1 | Participant) + (1 | Item), family = binomial, data = ds, control = glmerControl(optimizer = "bobyqa"))				
	Estimate	**SE**	**z value**	**Pr(|z|)**
Intercept	-2.8156	1.6515	-1.705	0.0882
Log Lexical Frequency	1.2982	-0.7297	-1.779	0.0752
Semantic Transparency Rating	8.0829	1.7774	4.548	<0.001
Random Effects				
	Variance	**SD**	**N**	
Participant	1.622	1.274	50	
Item	5.499	2.345	19	
Number of observations: 949;				
Marginal R2 / Conditional R2: 0.527 / 0.851				

[13] In cases where participants changed from one pattern to the other, the production was excluded from the analysis. Please note such cases were rare (5 cases out of 950 target location nouns).

[14] I would like to express my deep gratitude to Natalia Meir for conducting the statistical analysis.

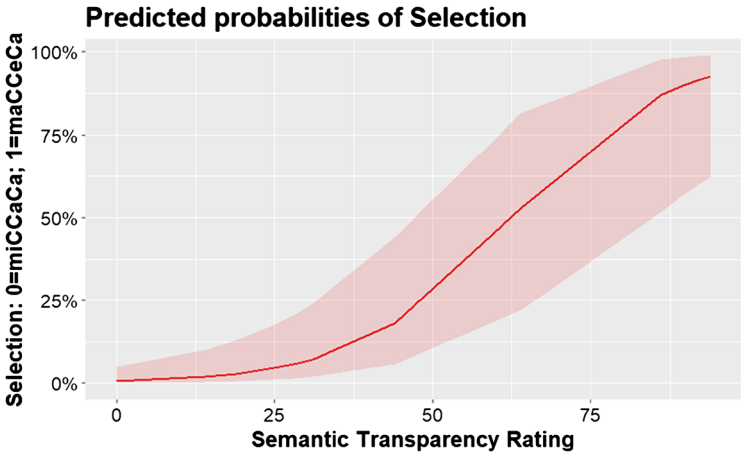

Fig. 1 Probabilities of Selection miCCaCa vs. maCCeca relative to the semantic transparency

The results of the experiment intertwine with the analysis in 3.3 and its predictions. They demonstrate a continuum that represents the degree of semantic transparency between location noun and verbal counterparts (if there are such counterparts). On one edge of the continuum, location nouns with low transparent relation to the verbal counterpart or with no verbal counterpart were almost all pronounced as *miCCaCa*. The noun *minhara* 'tunnel', for example, is not semantically related to the verb *nahar* 'flow (people)' and has no doublet **manhera*. On the other edge of the scale, there are nouns like *mispara* 'barber shop' and *mišxata* 'slaughter house' that demonstrate the most transparent semantic relations with the verbal system.[15] More than 75% of the participants produced them in the *maCCeCa* pattern. In between there are some location nouns that demonstrate greater degree of variation between the two location noun patterns. Though there is no one-to-one relation between the degree of variation and the degree of semantic transparency between these nouns and their verbal counterparts, there seems to be a strong tendency to use the *maCCeCa* pattern when the relation with the verb is more transparent.

Let us examine two borderline cases, where there is a semantic relation between the noun and the verb, but most speakers adhered to the *miCCaCa* pattern. The noun *mizlala* 'fast food restaurant' is semantically related to the verb *zalal* 'over eat', yet the relations between them are less transparent. I assume that when this location noun was termed, it was indeed based on the verb *zalal*. However, from a synchronic point of view, a fast food restaurant is not necessarily the location where one over eats. *mizlala* is therefore not the typical location that corresponds to the action that the verb *zalal* denotes, and as a result there is less motivation for this noun to change into *mazlela*. This explains why only 16% of the speakers used this doublet. Similarly, *mixlaʔa* 'enclosure' is semantically related to the verb *kala* 'imprison', yet the

[15]The location nouns *maxšeša* 'hashish den' and *maxceva* 'quarry' are presented in the *maCCeCa* pattern as these are also considered the normative forms. This is because they used to be pronounced with the pharyngeal voiceless fricative *ħ* (which is still pronounced by some speakers). This resulted historically in vowel lowering from *i* to *a* and a change into the *maCCeCa* pattern.

semantic relation is not straightforward. *mixlaʔa* has a specific meaning of an enclosure for animals, and it is therefore not the typical place where one imprisons. Again, this makes this location noun retain its form in the *miCCaCa* pattern, as demonstrated by most participants (89%).

Other factors might account for the differences between the 19 location nouns that were examined, but none was found relevant. Word frequency can play a significant role in variation and in the application of morphological processes in general (see for example, Bybee, 1985, Bayan 1993), but not in this specific case, as it was shown by the statistical analysis (see (13)). Within the 19 location nouns, there are frequent ones that demonstrate and do not demonstrate variation (e.g. *mispara* 'barber shop' and *mixlala* 'college'), and less frequent ones that again, demonstrate and do not demonstrate variation (e.g. *mitpara* 'sewing workshop' and *midšaʔa* 'lawn'). In addition, there is no correlation between the consonants of the location nouns, and in particular the first stem consonant, and the selection of either pattern (but see Footnote 7 for 2 particular cases). It could have been the case that some consonants would trigger the selection of a pattern that begins with the high front vowel *i* or with the low vowel *a*, based on their place of articulation. Yet, again, this is not the case. Finally, there is no difference in the meaning of *miCCaCa* and *maCCeCa* realizations of the same noun, that is there is no differentiation of meaning that could account the selection of each variant. Assuming that specific items in the experiment do not have such special properties that distinguish between them and other items, we would expect all items to demonstrate the same or at least similar degree of variation. Since different items demonstrate different degrees of variation, there has to be another factor that is responsible for the differences.

Having ruled out possible criteria that could account for the degree of variation (and lack thereof), I adhere to the proposed account in 3.3. The results support the claim that this morphological change, and possibly other changes as well, is not motivated only by phonological, morphological and semantic properties of the words that undergo variation, but their relations with other words in a paradigm, if they belong to a paradigm. Specifically, doublet formation (and lack thereof) in this case, is triggered by derivational paradigms and the degree of semantic transparency between location nouns and their verbal counterparts.

5 Conclusions

This study accounted for cases of doublet formation in Hebrew location nouns. I argued that it is possible to provide a partial prediction of which nouns are likely to undergo morphological change and which one are not, or are less likely to do so. I have shown that while the shift from one pattern to another is primarily motivated by morpho-phonological and semantic criteria, these factors by themselves cannot explain why some location nouns have doublets. Having ruled out other possible phonological and semantic factors, as well as the issue of frequency that could have played a role in this change, I proposed an account that relies on the degree of semantic transparency within the paradigmatic relations between location nouns and their verbal counterparts. Location nouns are likely to undergo morphological change only

when they are part of a verb-noun derivational paradigm, and the semantic relations between them are highly transparent; the location noun denotes the typical location where the actions that the verb denotes is performed. The morphological change is performed by changing the pattern into a pattern that begins with the vowel *a*, which is more typical of derivational processes in Hebrew. In cases where there is no verbal counterpart, that is, there is no derivational paradigm, or the semantic relation is not transparent, there is no doublet formation.

The morphological change establishes more uniform and regular paradigms, in which there is a clear morphological association between their members. The picture that emerges is that the morphological mechanism does not examine only properties of bases or words in general in the application of morphological processes, but it also examines relations between words in both inflectional and derivational paradigms.

The study thus provides evidence to the important role of derivational paradigms in word formation and change, highlighting the strong correlation between form and meaning in the domain of paradigmatic relations. The study sheds light on the important role of semantic transparency with respect to morphological variation and change. While the study examines only Hebrew, its results could have implications for examining relations between verbs and location nouns cross-linguistically. The results could set the stage for typological studies that of such morphological and semantic relations.

Appendix A: Variation of location noun patterns experiment

This appendix provides more details on the experiment discussed in Sect. 4.

The following instructions were presented to the participants: "Thank you for your agreement to take part in the experiment. I am about to present you with a series of sentences that are unrelated to each other. Please read each sentence aloud and clearly and then indicate whether the sentence has a positive, negative or neutral connotation. There is no correct or incorrect answer, say whatever comes to your mind. The experiment will be recorded and the recordings are results will be used for academic research purposes only. Details of participants will remain confidential".

The experiment contained 19 sentences with location nouns of the *miCCaCa/maCCeCa* forms as demonstrated in (i)-(ii). The sentences were presented in unvowelled Hebrew orthography which does not distinguish between miCCaCa and maCCeCa forms. Below I also provide the transcription and the gloss (the *miCCaCa/maCCeCa* forms were not marked in bold in the experiment itself). All the items that were used in the experiment are listed in (12) in 4.4.

(i) כל הסטודנטים יושבים במדשאה בזמן ההפסקה
kol ha-studentim yošvim ba-**midša?a/** ba-**madše?a** bizam ha-hafsaka
'All the students sit in the loan during the break'

(ii) אני כנראה אפגוש אותו מחר במכבסה
ani kanire efgoš oto maxar ba-**mixbasa**/ba-**maxbesa**
'I will probably meet him at the laundromat tomorrow'

Appendix B: Semantic transparency experiment

The goal of this experiment was to evaluate the degree of semantic transparency (and lack thereof) between a location noun of the *miCCaCa* pattern and a related verb, where both the noun of the verb share the same consonantal root.

Speakers' intuitions about the relation between location nouns and verbs were tested in an experiment, where 36 participants, aged 19-48 (15 women, 21 men). All the participants were native speakers of Hebrew with medium/high socio-economic status and had at least 12 years of education. Participants were presented with the list of *miCCaCa* location nouns from the experiment in the paper, which were mixed between other nouns: instrument nouns and location nouns that are not formed in patterns (e.g. *moadon* 'club'). For each item, speakers had to write the most typical thing that one does in this item (for location nouns) or with this item (for instrument nouns, as fillers). Instrument nouns were used in order not to draw the speakers' attention that the experiment tested location nouns only. Each *miCCaC*a location noun was separated by at least two filler items. The study was approved by the review board of the Faculty of Humanities, Bar-Ilan University.

Answers were classified according to usage of verbs sharing the same root of the location noun, and lack thereof. For example, if speakers used the verb *darax* 'step'; in relation to *midraxa* 'sidewalk', the answer was coded as 1 (semantic relation); if speakers used another verb (or any lexical category) of a different root, e.g. *halax* 'walk', the answer was coded as 0 (no semantic relation). It was assumed that for location nouns that are related to verbs with high semantic transparency, speakers will use these verbs.

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Declarations

Competing Interests The author declares that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

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