Optimal Paradigms: a challenge from Judeo-Tripolitanian Arabic

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April, 2024

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Abstract

This work evaluates an extension to Optimality Theory proposed by McCarthy (2005), called Optimal Paradigms (OP). OP assumes that categories like noun and verb are not available to the phonology. Instead, systematic phonological differences between categories are derived by special analogy constraints that require uniformity between members of an inflectional paradigm.

One of the original cases McCarthy (2005) used to showcase OP comes from Moroccan Arabic. McCarthy proposed that a noun-verb asymmetry in the distribution of schwa in Moroccan Arabic can be predicted by OP using the different paradigm structures of nouns and verbs in the language and without direct reference to categories. In this work, we reevaluate this proposal using evidence from Judeo-Tripolitanian Arabic, an endangered variety of Arabic that is closely related to the Moroccan variety that McCarthy (2005) analyzes. We show that if we consider not only nouns and verbs, but also adjectives, OP can no longer predict the distribution of schwa in the different categories.

The empirical examination of OP has implications for the following questions about phonological theory: Does phonology see categories like noun and verb? Are paradigms grammatical entities? Is analogy operative in the phonological grammar? While the latter two questions will remain open, we argue that OP does not eliminate the necessity of category reference in phonology, disputing the main original motivation for the theory.

Acknowledgments

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1 Introduction

The first generative model of the phonology-morphology interface was introduced by Chomsky and Halle (1968). They proposed an interleaving model, relying on a principle called *'the cycle'*, in which phonological processes apply to a word in a stepwise fashion, starting from the most embedded constituent in the word's structure and proceeding outwards. This model was motivated by cases in which the phonology of morphologically-complex words applies opaquely (in the sense of Kiparsky 1971), making those words more similar to their subconstituents. Bermúdez-Otero (2018) has later named such cases *morphosyntactically-induced opacity*.

In Palestinian Arabic, for example, stressless high vowels are regularly syncopated in open syllables (/fihim-tu/ → [fhím-tu] *'you.pl understood'*). Syncope under-applies in forms such as [fihím-na] *'he understood us'*, where an object marker follows the stem. Brame (1974) attributed this under-application to a cyclic assignment of stress. Stress is assigned first to a subconstituent that does not include an object marker (/fihim/). Afterwards, stress is assigned again to the entire word. As schematically illustrated in (1), syncope of the stressless vowel is bled if that vowel was stressed somewhere along the derivation.

(1)   Derivation of [fihím-na] *'he understood us'* in cyclic theories:

$$fihim \xrightarrow[\text{Phonology}]{} f\'ihim \xrightarrow[\text{Morphology}]{} f\'ihim\text{-}na \xrightarrow[\text{Phonology}]{\text{No syncope}} fih\'imna$$

Since the introduction of Optimality Theory (OT; Prince and Smolensky 1993/2004), an alternative model of the phonology-morphology interface has emerged. The mechanism of the cycle has been adopted by serial extensions to OT, such as Stratal OT (Kiparsky, 2000, 2015; Bermúdez-Otero, 2011) and Cophonology Theory (Orgun, 1996; Inkelas and Zoll, 2007). In the classical OT model, however, a stepwise derivation is impossible because phonological processes apply in a fully parallel fashion. Therefore, as an alternative to the cycle, faithfulness constraints have been extended from referring to just input-to-output correspondence, to a new correspondence relation that holds between outputs. Theories assuming this kind

of correspondence go under the names Transderivational Faithfulness, Output-to-Output Correspondence, Base-Derivative Correspondence, and Paradigm Uniformity (e.g., Kenstowicz 1996; Benua 1997; Steriade 1999; Kager 1999; Albright 2010).

Kager (1999) proposed that an output-to-output mechanism can derive [fihím-na] using analogy to its subconstituent [fíhim] '*he understood*'. Put simply, an output-to-output faithfulness constraint, which requires similarity to the base, outranks the markedness constraint that motivates syncope. This ranking ensures that a stressless high vowel is syncopated in open syllables, unless it is stressed in the base form of the derived word:

(2)   Derivation of [fihím-na] '*he understood us'* in output-to-output theories:

$$\textit{fihim} \xrightarrow[\text{Morphology}]{} \textit{fihim-na} \xrightarrow[\text{Phonology}]{\text{Base: } \textit{fíhim}} \textit{fihímna} \ (*\textit{fhímna})$$

As illustrated in Figure 1, cyclic theories and output-to-output theories assume a completely different architecture of the phonology-morphology interface. The interleaving model of the cycle allows a back-and-forth communication between the two modules. The morphology creates an input to phonology, which can generate either the surface form or an intermediate form, which can undergo further morphological or phonological processes. In the alternative model, however, morphology and phonology have one window of opportunity to apply. To account for the resemblance of related words, the phonology can perform analogy between them.
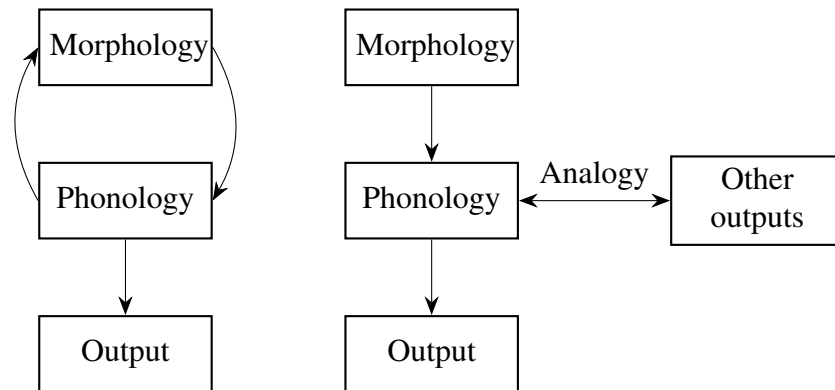
Figure 1: Cyclic model of grammar (left) vs. analogical model (right)

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Faithfulness constraints have later been further extended from referring to a one-way correspondence between a 'base+suffix' form and its base, to a symmetric correspondence relation that holds between each pair of paradigm members. The difference between the two kinds of output-to-output correspondence is shown in Figure 2, borrowing Cable's (2004) visualization.
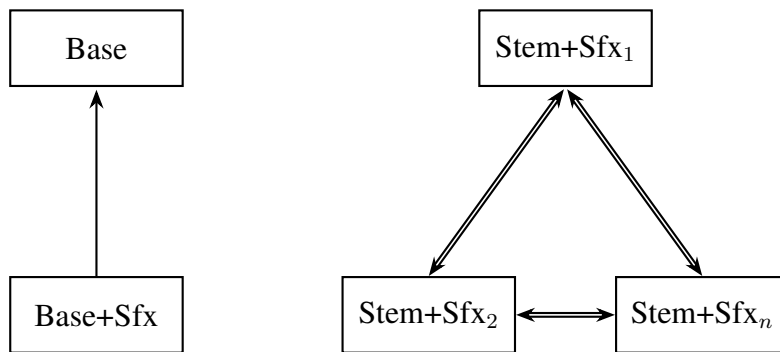
Figure 2: Two types of output-to-output correspondence: Base-Derivative Correspondence (left) vs. Optimal Paradigms (right).

The focus of this paper is on a theory that assumes such a symmetric intra-paradigmatic correspondence, called Optimal Paradigms (OP; McCarthy 2005). In OP, candidates are full inflectional paradigms and faithfulness constraints can require uniformity between all members within a candidate. What distinguishes it from other output-to-output theories is that OP aspires to account for more phenomena than just opacity.

OP has been showcased with cases in which nouns and verbs exhibit different phonological patterns. McCarthy (2005) proposed that the predictor of such category-distinct behaviour is faithfulness between paradigm members, rather than the syntactic categories themselves. His hope was that category-specific phonological patterns could be explained without the phonology making category-specific reference whatsoever. Bobaljik (2008) named this approach *"the thesis of category-neutral phonology"*.

One of the original cases McCarthy (2005) used to showcase OP comes from Moroccan Arabic. In this case study, tri-consonantal verbs always surface as CCəC. Tri-consonantal nouns, however, are restricted by sonority conditions. Nouns surface as CəCC if their sec-

ond consonant is more sonorant than the third in accordance with the Sonority Sequencing Generalization (SSG; Selkirk 1984). Only otherwise the noun surfaces as CCəC like verbs do. This distinct behaviour can lead to minimal pairs across categories, as exemplified in (3).

(3)   A noun-verb minimal pair in Moroccan Arabic (McCarthy, 2005)

ʃə́rb   *'drinking'*   ∼   ʃrə́b   *'he drank'*

McCarthy (2005) proposed that the different position of schwa in (3) is not determined by category-specific constraints. He suggested that the distinct distribution of schwa across categories is predicted by OP using the different paradigm structures of verbs and nouns. We will explain his proposal in detail in section 2.2, but here is how it works in a nutshell. The phonology of Moroccan Arabic determines that stems, regardless of category, will surface as CCəC before C-initial suffixes (e.g., [ʃrə́b-na] '*we drank*'). Since verbs have mostly C-initial inflectional suffixes, OP can require that the position of schwa will be the same in the suffix-less form [ʃrə́b] in order to maintain uniformity with other CCəC stems. Per McCarthy (2005), Moroccan Arabic nouns have no inflectional paradigm and only for that reason, and not their category, their shape is determined by category-independent sonority-related constraints.

Bobaljik (2008) pointed out a weakness in showcasing OP with this and similar cases. Since there is a correlation between the syntactic categories and paradigm structure, such cases can be accounted for either by OP constraints or by category-specific constraints, rules, templates, etc. Bobaljik (2008) further challenged the motivation for OP with a case study from Itelmen. He argued that this case cannot be accounted for without the phonology making direct category reference. Such a reference, if indeed available to phonology, can also account for the patterns that motivated OP, making McCarthy's (2005) proposal redundant. We will discuss this argument in section 2.3. However, as Bobaljik (2008) noted, Itelmen does not provide a knock-down argument against the theory. Smith (2011) also examined several cases of category-distinct phonological behaviour and suggested that some of them cannot be explained without the phonology making category reference. Her survey, however, does not show a fur-

ther challenge to OP beyond Itelmen. The question whether paradigm structure or category reference predict distinct phonological behaviour therefore remains an open question.

Answering this question has important implications for phonological theory, summarized in Figure 3. First, what information flows between the modules of grammar? Specifically, does phonology see syntactic categories? Second, are paradigms grammatical entities? In particular, do they play a role in phonological computation? And last, is analogy operative in the phonological grammar? While not answering the latter two questions unequivocally, we will argue that syntactic categories must be available to phonology, based on a case study from Judeo-Tripolitanian Arabic.

Theoretical inquiries	OP assumptions	Our argument
Are syntactic categories available to phonology?	✗	✓
Are paradigms grammatical entities?	✓	?
Is analogy operative in the phonological grammar?	✓	?

Figure 3: What is at stake? The theoretical implications of this study.

Judeo-Tripolitanian Arabic is an endangered variety of Arabic that is closely related to the Moroccan variety that McCarthy (2005) analyzes. In Judeo-Tripolitanian Arabic, schwas are distributed in verbs and nouns exactly as in Moroccan Arabic. We will see, however, that if we also take adjectives into consideration, paradigm structure can no longer predict the distinct behaviour of the three different categories: Schwa is distributed in adjectives as in verbs, but contradictory to OP, adjectives share the paradigm structure of nouns. As summarized in (4), the distribution of schwa in adjectives challenges OP because it defies the OP prediction that category-distinct behaviour should align with paradigm structure. Judeo-Tripolitanian Arabic therefore disputes the original motivation for OP, coming from a similar pattern from Moroccan Arabic.

(4) A schematic summary of the challenge from Judeo-Tripolitanian Arabic

$$\overbrace{\text{Verb} \quad \underbrace{\text{Adj} \quad \text{Noun}}_{\text{Paradigm structure}}}^{\text{Phonological behavior}}$$
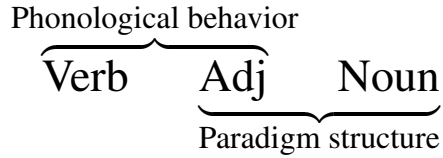
The paper is structured as follows. In section 2 we introduce OP. We present the motivation for the theory from Classical Arabic and then the core case study from Moroccan Arabic which constitutes crucial background for our argument. Before moving on, we review Bobaljik's (2008) previous case for scepticism regarding the theory, and briefly discuss the advantages of our new case study. In section 3 we present the new case study from Judeo-Tripolitanian Arabic. First, we show data from nouns and verbs that reflect the same generalizations that hold in nouns and verbs in Moroccan, and then, we show the data from adjectives that goes beyond McCarthy's (2005) examples. Finally, we show how the data contradict the predictions of OP.

2   Optimal Paradigms (OP)

2.1   The motivation for OP from Classical Arabic

The original case study given by McCarthy (2005) as motivation for OP shows a noun-verb asymmetry in Classical Arabic. As McCarthy pointed out, verbal stems are restricted to the templates in (5) and must end with a CVC syllable. Examples include fa.**ʕal**, faʕ.**ʕal**, faː.**ʕal**, tfaʕ.**ʕal**, tfaː.**ʕal**, nfa.**ʕal**, jaf.**ʕal**, ju.faʕ.**ʕil**, ju.faː.**ʕil**, ja.ta.faʕ.**ʕal**, ja.ta.faː.**ʕal**, and more.

(5)   Possible verbal templates: all stems have a final CVC syllable.

$$\text{(C)} \begin{Bmatrix} \text{CV} \\ \text{CVC} \\ \text{CV:} \end{Bmatrix} .\text{CVC}$$

Nouns, on the other hand, have no such restriction and their stems can end with either CVC, CV:C, or CVCC syllables, as shown in (6). Examples include fa.**ʕal**, fa.**ʕaːl**, **faʕl**, daħ.**raħ**,

daħ.**ra:ħ**, and more.

(6) Possible nominal templates: the stem-final syllable is not restricted as in (5).

$$\left\{ \begin{array}{c} \text{CV} \\ \text{CVC} \\ \text{CV:} \end{array} \right\} \cdot \left\{ \begin{array}{c} \text{CVC} \\ \text{CVCC} \\ \text{CV:C} \end{array} \right\}$$

OP builds on McCarthy and Prince's (1996) proposal that a language's templates and canonical word forms are not restricted by template-specific constraints. McCarthy and Prince proposed that recurring phonological configurations are shaped solely by the prosodic constraints of the language. McCarthy's (2005) proposal was that category-specific restrictions could similary be derived by the general morphophonology of the language. Bobaljik (2008) has named this approach *"the thesis of category-neutral phonology"* (TCNP) to emphasize that, according to it, syntactic categories should not be available to phonology at all. According to the TCNP, systematic differences between verbs and nouns are solely epiphenomenal and should be derived without direct reference to the categories themselves.

Within a framework that obeys the TCNP, the asymmetry in (5)-(6) cannot be attributed to verb-specific constraints that restrict the possible verbal stem forms. McCarthy (2005) therefore proposed a category-independent analysis that explains the asymmetry using the different inflectional paradigms of the two categories. As shown in (7), verbs in Classical Arabic have V-initial as well as C-initial suffixes (which realize person, gender, and number), whereas nouns have only V-initial suffixes (which realize gender, number, and case).

(7) Inflectional suffixes in Classical Arabic

Verbs		Nouns	
V-Initial	C-initial	V-Initial	C-initial
-a, -at, -a:, -ata:, -u:, -u, -i:na, -a:ni, -u:na.	-tu, -ta, -ti, -tuma:, -na:, -tum, -tunna, -na.	-u, -i, -a, -a:, -aj, -u:, i:.	∅

The difference between the types of suffixes can make the noun-verb asymmetry predictable by the extension to OT proposed by McCarthy (2005), called Optimal Paradigms (OP). Its basic premises are presented in (8).

(8) The basic premises of Optimal Paradigms (McCarthy 2005)

- Candidates are full inflectional paradigms.

- All stems in a paradigm are in a correspondence relation with each other.

- In addition to markedness and input-to-output faithfulness constraints, there are output-to-output faithfulness constraints that require similarity between corresponding members in a paradigm (OP constraints).

With the properties in (8), as we will now see, a general constraint ranking of Classical Arabic can rule out non CVC-final verbal stems, using an OP constraint and without referencing nouns or verbs directly. Consider a hypothetical UR with a final CV:C syllable, /faʕaːl/, and a markedness constraint that penalizes tri-moraic syllables such as CV:C, $*\mu\mu\mu]_\sigma$. This constraint is violated by forms such as *[faʕaːl-tu], in which the verbal stem is followed by a C-initial suffix. The markedness constraint can therefore motivate shortening before C-initial suffixes (/faʕaːl-tu/ $\rightarrow$ [faʕal-tu]). Consider now an OP constraint that requires uniformity in vowel length across the entire paradigm. This constraint is violated by non-uniform paradigms such as {faʕaltu, faʕaːla, ... }, in which corresponding vowels show discrepancy in length. The OP constraint can therefore motivate shortening before V-initial suffixes, despite the fact that such forms do not violate the markedness constraint that motivates shortening. The logic of this proposal is schematically illustrated in (9).

(9) fa.**ʕaːl**.tu $\xrightarrow[*\mu\mu\mu]_\sigma]{\text{Markedness}}$ fa.**ʕal**.tu

fa.**ʕaː**.la $\xrightarrow{\text{Uniformity}}$ fa.**ʕa.l**a

We will now see how the proposal works in more detail, using the constraints in (10). Apart from the markedness and OP constraints that have already been mentioned, the analysis

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includes an input-to-output faithfulness constraint that penalizes changes in vowel length.

(10)   Classical Arabic constraints (McCarthy, 2005)

    a. $*\mu\mu\mu]_{\sigma}$: Assign * for a tri-moraic syllable.

    b.   OP-IDENT(long): Assign * for every vowel that differs in length from its corre-spondent in another paradigm member.

    c.   IO-IDENT(long): Assign * for every vowel in the output that differs in length from its input.

The ranking of $*\mu\mu\mu]_{\sigma}$ above IO-IDENT(long) determines that a long vowel in a stem-final syllable is shortened before C-initial suffixes. The ranking of OP-IDENT(long) above IO-IDENT(long) determines that the same vowel is also shortened before V-initial suffixes, in order for the paradigm to be uniform, as shown in (11).[1]

(11)   An OP analysis of verbs in Classical Arabic (McCarthy, 2005)

	/faʕaːl/ + {a, tu, ...}	$*\mu\mu\mu]_{\sigma}$	OP-IDENT	IO-IDENT
a.	⟨fa.ʕaː.la, fa.ʕaːl.tu, ...⟩	*!		
b.	⟨fa.ʕaː.la, fa.ʕal.tu, ...⟩		*!	*
c. ☞	⟨fa.ʕa.la, fa.ʕal.tu, ...⟩			**

The candidate in (11a) consists of a uniform paradigm with faithful members, all of which have a long vowel in the stem-final syllable. This candidate violates $*\mu\mu\mu]_{\sigma}$, since some members of its paradigm have a tri-moraic syllable. The candidate in (11b) consists of a non-uniform paradigm, with unfaithful members before C-initial suffixes (that satisfy $*\mu\mu\mu]_{\sigma}$) but faithful members before V-initial suffixes. This candidate violates OP-IDENT(long), as it has members that differ from each other in the length of corresponding vowels. The candidate in (11c)

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[1]For simplicity, we follow McCarthy in assigning violations only for the paradigm members that are explicitly shown in the tableaux, although the candidates include full inflectional paradigms with more members. The precise number of violations of $*\mu\mu\mu]_{\sigma}$ and OP-IDENT(long) does not play a role here, because one violation of either of them is sufficient to disqualify a candidate.

consists of a uniform paradigm, with unfaithful members across the board. This is the optimal candidate as it satisfies both $*\mu\mu\mu]_\sigma$ and OP-IDENT(long).

In nouns, on the other hand, a stem-final CV:C syllable is permitted as it should. As can be seen in (12), since nouns have only V-initial suffixes, the uniform and faithful candidate in (12a) satisfies both $*\mu\mu\mu]_\sigma$ and OP-IDENT(long), with no violations of IO-IDENT(long).

(12)   An OP analysis of nouns in Classical Arabic, using the constraints in (11)

/faʕaːl/ + {u, i, ...}	$*\mu\mu\mu]_\sigma$	OP-IDENT	IO-IDENT
a. ☞ ⟨fa.ʕaː.lu, fa.ʕaː.li, ...⟩			
b. ⟨fa.ʕa.lu, fa.ʕa.li, ...⟩			**

McCarthy (2005) also showed that a stem-final CVCC syllable can be ruled out in verbs but not in nouns without direct reference to categories, using a similar OP constraint.

The OP analysis above shows that analogy between paradigm members eliminates the necessity of category reference in accounting for the noun-verb asymmetry in Classical Arabic. In what follows we will examine another fundamental case study McCarthy (2005) used to showc that OP can eliminate the necessity of direct reference to category. This is a case study of a noun-verb asymmetry in Moroccan Arabic that has a particular interest to us. In section 3, we will present new data from Judeo-Tripolitanian Arabic, a variety closely related to Moroccan Arabic, which exhibits the same pattern of McCarthy's (2005) Moroccan Arabic case. We will see that once we consider additional data, McCarthy's (2005) analysis fails to account for that pattern. We will argue that contrary to the prediction of OP, direct reference to categories cannot be replaced by paradigmatic analogy.

2.2   An OP account of the distribution of schwa in Moroccan Arabic

There has been extensive research on the distribution of schwa in Moroccan Arabic (see Kaye 1987; Benhallam 1989/1990; Boudlal 2006/2007, 2011; Bensoukas and Boudlal 2012). It is

established that schwa is always located between C_2 and C_3 in tri-consonantal verbs, which surface as CCəC (e.g., [ʃrə́b] *'he drank'*, [ktə́b] *'he wrote'*). Nouns of the same form, however, as can be seen in (13), surface as CəCC if C_2 is more sonorant than C_3. Only otherwise, the noun surfaces as CCəC.[2]

(13)   Moroccan Arabic's tri-consonantal nouns (McCarthy, 2005)

    a. C_1əC_2C_3 if $C_2 > C_3$ in sonority:

        kə́lb   *'dog'*

        bə́rd   *'wind'*

        də́nd   *'sin'*

        ʃə́mʃ   *'sun'*

        lə́ʕb   *'game'*

    b. C_1C_2əC_3 if $C_2 \leq C_3$ in sonority:

        rʒə́l   *'leg'*

        ktə́f   *'sholder'*

        ħbə́l   *'rope'*

        bɣə́l   *'mule'*

        wtə́d   *'peg'*

This distinct behaviour leads to noun-verb minimal pairs when $C_2 > C_3$ in sonority, as shown in (3) and repeated here in (14).

(14)   A noun-verb minimal pair in Moroccan Arabic (McCarthy, 2005)

    ʃə́rb *'drinking'* ∼ ʃrə́b *'he drank'*

Previous analyses accounted for this asymmetry by referencing nouns or verbs directly. Kaye (1987) analyzed it using different templates for nouns and verbs, as well as category-specific phonological rules. Boudlal (2006/2007) proposed noun-specific sonority constraints

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[2]Both verbs and nouns surface as CəCC if they end with a geminate (e.g., [ʃə́dd] *'to hold'*, [də́mm] *'blood'*; Boudlal 2006/2007). In any analysis, there could be a constraint that motivates this position of schwa if a form ends with a geminate. Because nouns and verbs do not differ from each other in this respect, forms with a geminate do not bear on the evaluation of OP.

within OT. However, an analysis under the TCNP, in which direct reference to category is forbidden, is not trivially possible. To see why, consider a cover constraint, which McCarthy (2005) called SONCON, that enforces the sonority-schwa dependency that is seen in nouns.[3] This constraint favors a CəCC surface form over CCəC when $C_2 > C_3$ in sonority, as shown in the tableaux in (15).

(15) An attempt to derive both nouns and verbs using SONCON.

a. The derivation of [ʃə́rb] *'drinking'* (noun) succeeds:

/ʃrb/	⋯	SONCON
a. ʃrə́b		*!
b. ☞ ʃə́rb		

b. The derivation of [ʃrə́b] *'he drank'* (verb) fails:

/ʃrb/	⋯	SONCON
a. ☹ ʃrə́b		*!
b. ☞ ʃə́rb		

As can be seen in (15), while SONCON favors the correct candidate in the derivation of the noun [ʃə́rb] *'drinking'*, as long as SONCON does not distinguish between categories, it also favors the same form *[ʃə́rb] *'he drank'*, which is ungrammatical for a verb. McCarthy (2005) proposed that an OP constraint that outranks SONCON can solve this problem. As we will see, by using the properties of paradigms in Moroccan Arabic, an OP constraint can prefer a verbal CCəC surface form but not a nominal CCəC form, without making direct reference to categories.

The following analysis relies on what McCarthy (2005) considers to be inflectional suffixes in Moroccan Arabic, which is summarized in (16).

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[3]McCarthy (2005) does not formalize SONCON. However, a possible deconstruction of SONCON can be done using Boudlal's (2006/2007) constraints. Put simply, Boudlal suggests that a schwa must share a mora with a consonant, and proposes constraints of the form *əX]$_\mu$, where S = stop, F = fricative, N = nasal, L = liquid, and G = glide. These are ranked in such way that it is better for a schwa to share a mora with X than with X' if X is more sonorant than X'. This is shown in the tableau below. Unlike McCarthy (2005), Boudlal (2006/2007) suggests that these constraints are noun-specific.

/ʃrb/	*əS]$_\mu$	*əF]$_\mu$	*əN]$_\mu$	*əL]$_\mu$	*əG]$_\mu$
a. ☞ ʃərb				*	
b. ʃrəb	*!				

(16) Inflectional suffixes in Moroccan Arabic according to McCarthy (2005)

Verbs		Nouns	
V-Initial	C-initial	V-Initial	C-initial
ət, -u	-t, -na, -ti, -tu	$\emptyset$	$\emptyset$

The list in (16) consists of the inflectional suffixes of the verbal perfect paradigm, exemplified in (17) for [ʃrə́b] *he drank*.[4] Per McCarthy (2005), nouns do not have inflectional suffixes. We will get back to this assumption later.

(17) Moroccan Arabic's verbal paradigm (McCarthy, 2005)[5]

Inflection		Suffix	SR	
1	SG	-t	ʃrə́bt	
	PL	-na	ʃrə́bna	
2	SG	-ti	ʃrə́bti	CCəC
	PL	-tu	ʃrə́btu	
3	MSG	$\emptyset$	ʃrə́b	
	FSG	-ət	ʃə́rbət	CəCC
	PL	-u	ʃə́rbu	

As can be seen in (17), except for the form [ʃrə́b], schwa is also located between C_2 and C_3 in stems that precede C-initial suffixes. Schwa is located between C_1 and C_2 only in stems that precede V-initial suffixes. As we will see, OP can predict the locus of schwa in the suffix-less form [ʃrə́b] using the fact that the verbal paradigm contains more C-initial than V-initial suffixes. As will be explained in more detail immediately, OP favors a suffix-less form that is

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[4]For simplicity, McCarthy (2005) does not include the imperfective verb in his demonstration. However, he notes that his analysis should work either way.

[5]The numbers 1, 2, and 3 indicate person, SG and PL indicate singular and plural, and M and F indicate masculine and feminine.

similar to most of its corresponding members in the paradigm.

Apart from SONCON, which has already been mentioned, McCarthy (2005) uses two markedness constraints and an OP constraint for his Moroccan Arabic analysis:

(18) Moroccan Arabic constraints (McCarthy, 2005)

    a. *CCC: Assign * for every sequence of three consonants.

    b. *ə]$_\sigma$: Assign * for every schwa in an open syllable.

    c. OP-MAX-V: Assign * for each pair of members in a paradigm in which one member has a vowel in a position where the other member does not.

    d. SONCON: Assign * for a CCəC form if $C_2 > C_3$ in sonority.

Both markedness constraints, *CCC and *ə]$_\sigma$, reflect broad generalizations in the language. The first, *CCC, penalizes sequences of three consonants. The second, *ə]$_\sigma$, penalizes schwas in open syllables. The first is violated by forms such as *[ʃə́rb-t] and can therefore motivate the occurrence of schwa between C_2 and C_3 before C-initial suffixes (/ʃrb-t/ → [ʃrə́b-t]). The second is violated by forms such as *[ʃrə́b-u] and can motivate the occurrence of schwa between C_1 and C_2 before V-initial suffixes (/ʃrb-u/ → [ʃə́rb-u]). Apart from them, McCarthy (2005) introduces an OP constraint, OP-MAX-V, that requires uniformity between paradigm members with respect to the position of vowels. This constraint is violated twice by a pair of corresponding members, such as ⟨ʃrə́b-t, ʃə́rb-u⟩, in which one member has a schwa where the other does not, and vice versa. This OP constraint can therefore motivate a schwa between C_2 and C_3 in the suffix-less form [ʃrə́b], although the alternative [ʃə́rb] does not violate any markedness constraints. The logic of this proposal is illustrated in (19).[6]

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[6]We assume that schwas in Moroccan Arabic are epentethic, following the studies of Benhallam (1989/1990), Boudlal (2006/2007), and Bensoukas and Boudlal (2012). However, as pointed out by McCarthy (2005), this assumption is not crucial because the analysis works with either underlying representation /ʃrb/, /ʃrəb/, /ʃərb/, or /ʃərəb/.

(19) ʃrb-t $\xrightarrow[\text{*CCC}]{\text{Markedness}}$ ʃrə́bt

ʃrb-u $\xrightarrow[\text{*ə]}_\sigma]{}$ ʃə́rbu

ʃrb $\xrightarrow{\text{Uniformity}}$ ʃrə́b

As can be seen in (20), the ranking of *CCC and *ə]$_\sigma$ above OP-MAX-V favors candidates (20a) and (20b), in which no member violates *CCC or *ə]$_\sigma$, even though their paradigms are not entirely uniform. The ranking of OP-MAX-V above SONCON determines that the position of schwa in the suffix-less member is aligned with the majority of the paradigm (i.e., schwa falls between C$_2$ and C$_3$), even when it violates SONCON (i.e., when the second consonant of the suffix-less member is more sonorant than the third).

(20) An OP analysis of the distribution of schwa in Moroccan Arabic verbs (McCarthy, 2005)

	/ʃrb/ + {t, na, ti, tu, ət, u}	*ə]$_\sigma$	*CCC	OP-MAX-V	SONCON
a. ☞	⟨ʃrə́b, ʃrə́bt, ʃrə́bna, ʃrə́bti ʃrə́btu, ʃə́rbət, ʃə́rbu⟩			20 *'s	*
b.	⟨ʃə́rb, ʃrə́bt, ʃrə́bna, ʃrə́bti ʃrə́btu, ʃə́rbət, ʃə́rbu⟩			24 *'s!	
c.	⟨ʃrə́b, ʃrə́bt, ʃrə́bna, ʃrə́bti ʃrə́btu, ʃrə́bət, ʃrə́bu⟩	*!*			*
d.	⟨ʃə́rb, ʃə́rbt, ʃə́rbna, ʃə́rbti ʃə́rbtu, ʃə́rbət, ʃə́rbu⟩		*!***		

Candidate (20d) consists of a uniform paradigm with CəCC stems across the board, so four of its members (every member with a C-initial suffix) violate *CCC. Candidate (20c) also consists of a uniform paradigm, albeit with CCəC stems, so two of its members (every member with a V-initial suffix) violate *ə]$_\sigma$. Since *CCC and *ə]$_\sigma$ are undominated, both candidates are

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ruled out. The competition is therefore between candidates (20a) and (20b) and is decided by the number of OP-MAX-V violations. Both candidates consist of CCəC stems before C-initial suffixes and CəCC stems before V-initial suffixes, which satisfy the higher-ranked markedness constraints. The two candidates differ only by the shape of their suffix-less member, [ʃrə́b] in (20a) and [ʃə́rb] in (20b). This difference translates into a difference in the number of constraint violations. In (20a) there are five CCəC stems and two CCəC stems, which incur a total of 20 violations of OP-MAX-V ($5 \cdot 2$ pairs of $\langle$CəCC, CCəC$\rangle \cdot 2$ violations for each pair). In (20b), on the other hand, there are four CCəC stems and three CCəC stems, which incur a total of 24 violations of OP-MAX-V ($4 \cdot 3 \cdot 2$). Candidate (20a) is therefore chosen, although it also violates the lower ranked SONCON.

Recall now McCarthy's (2005) assumption that Moroccan Arabic nominal inflections do not constitute paradigms for the purpose of OP. To justify this stipulation, McCarthy (2005) points out that colloquial Arabic varieties, including Moroccan, have lost the inflectional case marking of Classical Arabic, that possessive clitic pronouns are not part of the inflectional paradigm, and that broken plurals are not formed by suffixation. We will not reflect on this stipulation, as the question of what constitutes a paradigm can remain in a black box while we test OP. We will see later that OP fails with respect to our case study, regardless of any assumption about the paradigm.

For now, however, under McCarthy's (2005) assumption, nominal candidates consist of only one suffix-less member. As shown in (21), nouns therefore vacuously satisfy OP-MAX-V. Since neither a CəCC form nor a CCəC form violates the higher-ranked markedness constraints, the position of schwa is determined by SONCON.

(21)   An OP analysis of the distribution of schwa in Moroccan Arabic nouns (McCarthy, 2005)

	/ʃrb/	*ə]$_\sigma$	*CCC	OP-MAX-V	SONCON
a.	ʃrə́b				*!
b. ☞	ʃə́rb				

Noun derivations can therefore be seen as cases of the emergence of the unmarked (McCarthy and Prince, 1994), in which the sonority preference of Moroccan Arabic appears because nominal candidates consist of a single member and higher-ranked constraints are inactive. Per McCarthy (2005), this is not a noun-specific preference, but rather a category-independent preference that does not emerge in verbs because of their paradigm structure. As we will show in section 3, if we consider adjectives as well, we will have to reevaluate this proposal. We will see that the categories themselves must be available to phonology, in order to predict the position of schwa across all categories.

2.3 Bobaljik's (2008) case for scepticism and its limitations

The significance of the new challenge to OP from Judeo-Tripolitanian Arabic will be better understood after discussing a previous notable challenge to the theory, made by Bobaljik (2008). In addition to conceptual arguments, Bobaljik raised doubt about OP using evidence from Itelmen. As he noted, however, the Itelmen case does not constitute a knock-down argument against the theory. As also shown by Cable (2004), OP can rise to the Itelmen challenge under certain assumptions and when combined with other OT extensions. In what follows we will briefly discuss Bobaljik's (2008) challenge to OP and see why OP can resolve it.

In Itelmen, schwa epenthesis occurs between two consonants in coda position if the second consonant is a sonorant or /z/ (e.g., /spl/ → [spəl] 'wind'). This process over-applies in verbs (e.g., /spl-in/ → [spəl-in] *windy*-3SG 'it was windy', *[spl-in]) but not in nouns (e.g., /spl-ank/ → [spl-ank] 'wind-direct.locative', *[spəl-ank]). Bobaljik argued that such an asymmetry between categories cannot be explained by OP using paradigm structure as an alternative to direct

reference to categories. Per Bobaljik, both inflectional paradigms of verbs and nouns in Itelmen consist of C-initial suffixes (which create the environment for epenthesis), as well as V-initial suffixes (which remove the necessary environment). Hence, an OP constraint cannot explain why epenthesis over-applies in one category but not in the other.

Such an asymmetry, however, can be predicted by OP under a similar stipulation to the one McCarthy (2005) has made for Moroccan Arabic, that verbal inflections constitute paradigms (and therefore can face pressure for uniformity), while nominal inflections do not. Under this assumption, epenthesis in verbs, which is sometimes required by markedness constraints (e.g., /spl-qzu-in/ → [spəl-qzu-in] *windy*-ASP-3SG '*it was windy*') over-applies across the paradigm to satisfy an OP constraint (e.g., /spl-in/ → [spəl-in] *windy*-3SG '*it was windy*'). In contrast, if nouns do not constitute inflectional paradigms, epenthesis will apply when markedness constraints require it (e.g., /spl/ → [spəl] '*wind*'), but not otherwise (e.g., /spl-ank/ → [spl-ank] '*wind*.direct.locative', *[spəl-ank]).

As Bobaljik (2008) pointed out, there are good reasons to reject such a stipulation. We avoid getting into this debate despite the importance of the definition of the paradigm for the purpose of OP. Although the definition of the paradigm is certainly relevant to the question whether paradigms are predictors of phonological behaviour, it can remain undecided. This is because, as we will see, the new challenge from Judeo-Tripolitanian Arabic cannot be resolved under any assumption about the paradigm.

Bobaljik (2008) presented a further challenge to OP from Itelmen's intransitive verbs. Apart from the over-application of epenthesis before V-initial suffixes that has just been discussed, Itelmen exhibits another kind of opacity in present-tense inflections. The C-initial suffix /-kit͡ʃen/ '1SG', which begins with a voiceless consonant, causes the devoicing of the present-tense suffix /-z/. While /z/ can trigger epenthesis, its voiceless counterpart, s, cannot. Therefore, across the present paradigm, epenthesis not only over-applies before V-initial suffixes (e.g., /il-z-in/ → [il-əz-in] '*he drinks*'), but also before this voiceless C-initial suffix (e.g.,

/t'-il-z-kit͡ʃen/ → [t'-il-əs-kit͡ʃen] '*I am drinking*'), where epenthesis is counter-bled by a de-voicing process. Bobaljik (2008) shows that a cyclic derivation can account for both opaque interactions:

(22)　Cyclic derivations of the root /il/ *'drink'* (cf. Bobaljik 2008)

UR	/il-z-in/	/t'-il-z-kit͡ʃen/
Cycle I	/il-z/	/il-z/
Epenthesis	iləz	iləz
Cycle II	/iləz-in/	/t'-iləz-kit͡ʃen/
Devoicing	-	t'iləskit͡ʃen
SR	[iləzin]	[t'iləskit͡ʃen]

What makes intransitive verbs particularly challenging to OP is that the application of epenthesis in their present paradigms is opaque across the board. Whereas the transitive verb has voiced C-initial suffixes that create a transparent environment for epenthesis (e.g., /sk-z-nen/ → [sk-əz-nen] '*he is making it*'), the intransitive verb does not. The absence of a trans-parent application of epenthesis poses a challenge to OP that is schematically illustrated in (23). OP can try to determine that epenthesis over-applies before V-initial suffixes to satisfy an OP constraint that requires uniformity with other paradigm members. But no markedness constraint can motivate epenthesis in *any* member of the intransitive paradigm.

(23)　/t'-il-z-kit͡ʃen/　$\xrightarrow[\textcolor{red}{?}]{\textcolor{red}{\text{Markedness}}}$　[t'iləskit͡ʃen]

　　　/ilz-in/　$\xrightarrow{\text{Uniformity}}$　[iləzin]

This challenge to OP, however, is just an instantiation of the general challenge opacity poses to parallel OT (e.g., Kiparsky 2000; McCarthy 2003, 2007). If the model could have accounted for the opaque application of epenthesis in [t'-il-əs-kit͡ʃen], OP could have required epenthesis in [il-əz-in] as well. Indeed, Cable (2004) showed that OP can derive this pattern when combined with Sympathy Theory (McCarthy, 1999), an OT extension that can account

for over-application opacity arising from counter-bleeding. Alternative solutions may also be developed when OP is combined with other OT extensions, such as Stratal OT and OT with Candidate Chains (OT-CC; McCarthy 2007), that can deal with this and other kinds of opacity.

To summarize this section, Bobaljik's (2008) case for scepticism has limitations thar make the challenge from Itelmen solvable within OP. This challenge can be resolved without direct reference to categories when OP is combined with other OT extensions, and under a stipulation about the paradigm. As we will see, the new case presented in this paper is free of these limitations. The challenge from Judeo-Tripolitanian Arabic cannot be resolved by any combination of familiar OT extensions or under any assumption about what constitutes a paradigm, and thus poses a stronger challenge to OP.

3 The challenge to OP from Judeo-Tripolitanian Arabic

3.1 Judeo-Tripolitanian Arabic: language background

Judeo-Tripolitanian Arabic (henceforth, JTA) is a variety of Arabic that used to be spoken in Tripoli, the capital city of Libya. JTA is one of several varieties spoken today exclusively by Jews who emigrated to Israel from Arabic speaking countries. In Israel, the speakers were under pressure to abandon their mother tongue in favor of Hebrew, and therefore did not pass it on to younger generations (see Hary 2019 for a political and historical discussion). These varieties are sometimes given the collective name *Judeo-Arabic*, even though they come from different corners of the Middle East and North Africa, and are more distinct from each other than from other varieties of their origin area. JTA also shares multiple linguistic characteristics with Moroccan and other Arabic varieties of the Maghreb (the Arabic northern part of Africa, which includes Algeria, Libya, Mauritania, Morocco, Tunisia, and Western Sahara; Goldberg 1983).

Since their immigration to Israel, the number of JTA speakers has been declining. In 1943

there were approximately 30,000 Jews in Libya. Most of them immigrated to Israel between 1949 and 1952 (Goldberg, 1983). Today an estimated number of only a few hundred native speakers of JTA are under the age of 65, which makes this variety critically endangered. This estimation is based on the reports of the Israeli Central Bureau of Statistics, which provides the ages of Libya-born Israeli citizens.[7,8] As Figure 4 and Table 1 show, the number of speakers has been rapidly decreasing over the past twenty years.
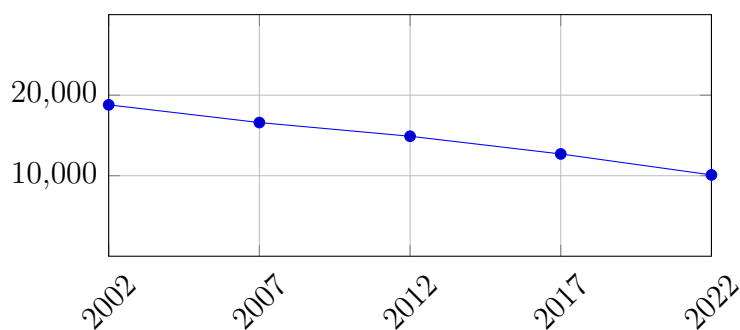

Figure 4: The change in the number of Libya-born Jews between the years 2002 and 2022, according to the Israeli Central Bureau of Statistics.

Year	All ages	Age 55+	Age 55+ (%)	Age 65+	Age 65+ (%)
2002	18.8	14.8	78.72%	7.8	41.49%
2022	**10.1**	**10**	**99.01%**	**9.5**	**94.06%**

Table 1: The number of Libya-born Jews in Israel in all ages, over 55, and over 65, in the years 2002 and 2022.

Apart from being endangered, JTA is also under-researched. Yoda (2005) has laid the ground for the research of this variety with an in-depth documentation of it. Yoda had elicited a total of 35 hours of speech from nine different informants, seven of whom immigrated to Israel from Tripoli in 1949-1952 and two in 1967. Yoda's description provides many insights into the phonology and morphology of JTA and includes a significant portion of the crucial data that

[7]"*Population – Statistical Abstract of Israel 2003 – No.54*" by the Israeli Central Bureau of Statistics. The full report is available online here: https://www.cbs.gov.il/en/publications/Pages/2003/Population-Statistical-Abstract-of-Israel-2003-No54.aspx.

[8]"*Population – Statistical Abstract of Israel 2023 – No.74*" by the Israeli Central Bureau of Statistics. The full report is available online here: https://www.cbs.gov.il/en/publications/Pages/2023/Population-Statistical-Abstract-of-Israel-202-No-74.aspx.

we will use below. However, we have verified the examples we will see in an independent field research, to make sure that the relevant data are all generated by the same individual grammar (see de Lacy 2014 for the importance of this point). As far as we know, this work constitutes the first theoretical study of the variety.

We have elicited about 5,000 different words and sentences from a single JTA native speaker, during over 25 hours of recordings. The speaker was born in Tripoli in 1947 and immigrated with his family to Israel in 1949. Growing up, he continued to speak JTA at home and in the community. Most of the examples presented below can also be found in Yoda's documentation and any datum found in both studies shows no discrepancies that are relevant to this paper.

In what follows, we will see how the distribution of schwa in JTA adjectives challenges OP. In section 3.2 we will see that the distribution of schwa in JTA verbs and nouns follows exactly McCarthy's (2005) generalizations for Moroccan Arabic. In section 3.3 we will present additional data from JTA adjectives. Then, in section 3.4, we will see how the distribution of schwa in JTA adjectives contradicts the predictions of OP.

3.2   The distribution of schwa in JTA nouns and verbs

Like other Maghrebi varieties of Arabic, JTA is characterized by fewer vowels than Classical Arabic (CA) and most colloquial varieties. Historically-long vowels are pronounced as short, whereas historically-short vowels are either replaced by schwa or omitted altogether. This characteristic is shown for all of JTA's verbal templates in (24). Their enumeration corresponds to the conventional numbers of verbal templates, traditionally called *Awzaan* in Arabic or *Binyanim* (*Binyan* in the singular) in Hebrew (see, for example, McCarthy 1981). *Binyanim* IV and IX of CA have no correspondents in JTA and are therefore absent from (24).

(24)   The verbal templates of JTA

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	JTA Template	CA Template	Example	Gloss
I	CCəC	CaCaC	kt͡ʃə́b	*'he wrote'*
II	CəC$_i$C$_i$əC	CaC$_i$C$_i$aC	fəkkə́r	*'he thought'*
III	CaCəC	Ca:CaC	barə́k	*'he blessed'*
V	t͡ʃCəC$_i$C$_i$əC	taCaC$_i$C$_i$aC	tsənnə́s	*'he listened'*
VI	t͡ʃCaCəC	taCa:CaC	t͡ʃqabə́l	*'he met'*
VII	nəCCəC	nCaCaC	nədrə́b	*'he was hit'*
VIII	Cət͡ʃCəC	CtaCaC	rət͡ʃʕád	*'he trembled'*
X	stəCCəC	staCCaC	staʕad͡ʒə́l	*'he hurried'*
XI	CCaC	CCa:C$_i$C$_i$	twal	*'he became tall'*

As shown in (24), across all verbal templates, there are no word-final complex codas. The final two consonants are separated by either a schwa (in *Binyanim* I-X) or by an [a] (in *Binyan* XI). The surprising [a] in [rət͡ʃʕád] is a schwa that is lowered to [a], following a pharyngeal consonant. Like in Moroccan Arabic, the distribution of schwa in verbs with triliteral roots is unconstrained by the sonority of the consonants.[9] This is shown in the verbal paradigms of *Binyan* I in (25), for the verbs [ʃrə́b] *'he drank'* where $C_2 > C_3$ in sonority; [gdə́m] *'he bit'*, where $C_2 < C_3$ in sonority; and [kt͡ʃə́b] *'he wrote'*, where $C_2 \simeq C_3$ in sonority.

(25) Perfect paradigms for [ʃrə́b], [gdə́m], and [kt͡ʃə́b]

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[9]In verbs of quadriliteral roots the case is slightly different. While sonority does not play a role in word-final clusters, it does in medial clusters of quadriliteral verbs. CCC medial clusters are allowed if $C_1 > C_2$ in sonority (e.g., [fə́rʃk-ət͡ʃ] *'she freshened'*). If $C_1 < C_2$ in sonority, however, a schwa is inserted after C_1 (e.g., [ʕáfəlk-ət͡ʃ] *'she choked'*).

Inflection	Suffix	ʃ.r.b	g.d.m	k.tʃ.b	
1 SG	-tʃ	ʃrə́btʃ	gdə́mtʃ	ktʃə́btʃ	
PL	-na	ʃrə́bna	gdə́mna	ktʃə́bna	
2 MSG	-tʃ	ʃrə́btʃ	gdə́mtʃ	ktʃə́btʃ	CCəC
FSG	-tʃi	ʃrə́btʃi	gdə́mtʃi	ktʃə́btʃi	
PL	-tʃu	ʃrə́btʃu	gdə́mtʃu	ktʃə́btʃu	
3 MSG	∅	ʃrə́b	gdə́m	ktʃə́b	
FSG	-ətʃ	ʃə́rbətʃ	gə́dmətʃ	kə́tʃbətʃ	CəCC
PL	-u	ʃə́rbu	gə́dmu	kə́tʃbu	

As can be seen in (25), regardless of the sonority of the consonants, schwas are located between C_2 and C_3 in the basic (3MSG) form and before C-initial suffixes, and between C_1 and C_2 before V-initial suffixes. This is precisely the Moroccan distribution of schwa that we have seen in section 2.2.

The distribution of schwa in JTA nouns is also identical to Moroccan Arabic's and, unlike verbs, is constrained by sonority. As can be seen in (26), McCarthy's (2005) generalizations hold for JTA as well. Nouns surface as CCəC only if $C_2 \leq C_3$ in sonority. If $C_2 > C_3$ in sonority, nouns surface as CəCC.[10]

(26) JTA tri-consonantal nouns

    a. C_1əC_2C_3 if $C_2 > C_3$ in sonority:

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[10]Like in Moroccan, in JTA both verbs and nouns surface as CəCC if C_2 and C_3 form a geminate (e.g., [ʃə́dd] *'he grabbed'* and [fə́mm] *'mouth'*). Again, this is not significant for us as there is no asymmetry between the categories in this respect.

kɛ́lb   *'dog'*

bɛ́ntʃ͡   *'girl'*

wɛ́ld   *'boy'*

sɛ́ms   *'sun'*

mɛ́lħ   *'salt'*

t͡ʃɛ́lʒ   *'ice'*

ʒɛ́mb   *'side'*

mɛ́rd   *'disease'*

fɛ́rn   *'pit oven'*

b. $C_1C_2\partial C_3$ if $C_2 \leq C_3$ in sonority:

xʃɛ́m   *'nose'*

ħbɛ́q   *'basil'*

lħɛ́m   *'meat'*

sdɛ́r   *'chest'*

bsɛ́l   *'onion'*

btɛ́n   *'stomach'*

fħɛ́m   *'coal'*

gdɛ́b   *'lie'*

kt͡ʃɛ́f   *'shoulder'*

Stridency may also play a role in the positioning of schwa. Words such as [lɛ́bs] *'clothes'*, [nɛ́fs] *'half'* , and [kɛ́bs] *'horned male sheep'*, in which $C_2 \leq C_3$ in sonority but C_3 is a strident, surface as CəCC. Since our relevant data only include these three examples, we refrain from making generalizations regarding stridents (however, Yoda (2005) has additional examples that suggest that nouns also surface as CəCC when $C_2 \leq C_3$ in sonority and C_3 is a strident). Apart from that, the only exception to McCarthy's (2005) generalization that we have found is [ħnɛ́ʃ] *'snake'* (which should have been *[ħɛ́nʃ] according to the relative sonority of the consonants). Incidentally, this word has also been reported as an exception to the pattern in Moroccan Arabic

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(Boudlal, 2006/2007).

Up until now, the phonological behaviour of JTA is exactly the same as the behaviour McCarthy (2005) assumed for Moroccan Arabic. In what follows, however, we will see the distribution of schwa in adjectives, which is not discussed in McCarthy's original analysis of Moroccan. Adjectives in JTA surface as CCəC regardless of sonority, like verbs, but share the paradigm structure of nouns. In section 3.4 we will see how this fact creates a paradox for OP. Heath (2002) and Boudlal (2006/2007) state that adjectives in Moroccan Arabic also surface as CCəC, which suggests that the same challenge is posed by Moroccan Arabic as well.

3.3   The distribution of schwa in JTA adjectives

JTA adjectives of the form that contains three consonants and a schwa correspond to adjectives of the form ʔaCCaC in CA. Many of them are from the adjectival category called *color/disability adjectives*,[11] which includes primarily colors and disabilities, but also other meanings. As can be seen in (27), the position of schwa in these adjectives is always between C_2 and C_3, regardless of the sonority of the consonants.

(27)   Color/disability adjectives in JTA[12]

    a. $C_2 > C_3$ in sonority:

        bjə́d   *'white'*

        zrə́q   *'blue'*

        trə́ʃ   *'deaf'*

        ħwə́l   *'cross-eyed'*

        ʕawə́r *'one-eyed'*

    b. $C_2 < C_3$ in sonority:

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[11]This adjectival category is sometimes inappropriately called *color/defect*.

[12]The vowel [a] in [ʕawə́r] *'one-eyed'* is epenthesized after /ʕ/ in JTA.

sfə́r   *'yellow'*

ħmə́r   *'red'*

xdə́r   *'green'*

kħə́l   *'black'*

ħlə́w   *'sweet'*

Other adjectives of such shape, which also correspond to ʔaCCaC in CA, are the comparative forms of JTA adjectives, as exemplified in (28).

(28)   JTA comparatives[13]

Regular form	Comparative	
kbír	kbə́r	*'big'*
smín	smə́n	*'fat'*
twél	twə́l	*'tall'*
zrér	zrə́r	*'small'*
qréb	qrə́b	*'close'*
qsér	qsə́r	*'short'*
dʕéf	dʕáf	*'skinny'*
bʕéd	bʕád	*'far'*
t͡ʃfóħ	t͡ʃfə́ħ	*'tasty'*
məzján	zjə́n	*'pretty'*

As can be seen in (28), the distribution of schwa in comparatives is unconstrained by sonority as well. In [qrə́b] and [zjə́n], for example, $C_2 > C_3$ in sonority, in [kbə́r] and [qsə́r] $C_2 < C_3$, and in [smə́n] and [t͡ʃfə́ħ] $C_2 = C_3$. We will see why this is challenging to OP once we consider the paradigm structure of adjectives in JTA, which will be presented immediately.

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[13]The [a]'s in the comparative forms of [dʕáf] *'skinny'* and [bʕád] *'far'* are schwas that are lowered to [a]'s after pharyngeal consonants. Yoda (2005) suggests that there are two kinds of rhotic consonants in JTA and that [zrér] *'small'* may be better transcribed as [zɣéʀ] to reflect the difference. However, the difference between the two rhotics in our recordings is less clear, perhaps an idiosyncratic property of our informant.

3.4 The challenge to OP from JTA adjectives

We have just seen the distribution of schwa in verbs, nouns, and adjectives separately from each other. The table in (29) shows the three categories side-by-side. As can be seen in the table, schwas are distributed in JTA adjectives exactly as in JTA (and Moroccan) verbs. Like both verbs and nouns, if $C_2 \leq C_3$ in sonority, schwa is located between C_2 and C_3 in tri-consonantal adjectives. Like verbs but unlike nouns, as highlighted in blue in (29), if $C_2 > C_3$, schwa is also positioned between C_2 and C_3 in adjectives.

(29) The distribution of schwa across categories

Verbs		Adjectives		Nouns		
CCəC				CəCC		
ʃrə́b	*'he drank'*	bjə́d	*'white'*	kə́lb	*'dog'*	$C_2 > C_3$
tlə́b	*'he asked'*	zrə́q	*'blue'*	bə́ntʃ͡	*'girl'*	in sonority
drə́b	*'he hit'*	trə́ʃ	*'deaf'*	wə́ld	*'boy'*	
qlə́q	*'he was fed up'*	qrə́b	*'closer'*	sə́ms	*'sun'*	
CCəC						
gdə́m	*'he bit'*	sfə́r	*'yellow'*	xʃə́m	*'nose'*	$C_2 \leq C_3$
kt͡ʃə́b	*'he wrote'*	kħə́l	*'black'*	sdə́r	*'chest'*	in sonority
xsə́l	*'he washed'*	qsə́r	*'shorter'*	ħbə́q	*'basil'*	
ħsə́b	*'he thought'*	smə́n	*'fatter'*	lħə́m	*'meat'*	

Recall McCarthy's (2005) analysis of Moroccan Arabic, in which category-independent constraints (embodied by SONCON) favor CəCC over CCəC if $C_2 > C_3$ in sonority. This is the sonority configuration in which the categories behave differently from each other. According to the analysis within OP, the reason that CəCC forms appear only in nouns is the paradigm structure of the categories. According to that analysis, since verbal stems surface as CCəC before C-initial suffixes, they also surface as CCəC in isolation. This is because an OP constraint that

requires uniformity between paradigm members outranks SonCon. This OP constraint forces the suffix-less form to align with the majority of the paradigm. OP thus predicts, as emphasized in (30), that if a stem surfaces as CCəC when $C_2 > C_3$ in sonority (in violation of SonCon), that stem must appear before more C-initial than V-initial inflectional suffixes.

(30)   The prediction of OP regarding the position of schwa in CCC sequences:

If C_1C_2əC$_3$ and $C_2 > C_3$ in sonority $\Rightarrow$ |C-initial| > |V-initial| inflectional suffixes.

While this prediction is consistent with the paradigm structures of verbs and nouns, this is not the case for JTA adjectives.

As can be seen from the inflection of [trə́ʃ] *'deaf'* in (31), the adjectival paradigm consists of only V-initial suffixes.

(31)   [trə́ʃ] *'deaf'* inflections

Inflection	SR	
MSG	trə́ʃ	CCəC
FSG	tərʃá	CəCC
PL	tərʃín	

Since adjectives in JTA have no C-initial suffixes at all, they contradict the prediction of OP. The position of schwa in the suffix-less form is CCəC, even though the adjectival stem does not appear before any C-initial suffix (and hence, contradictory to (30), does not appear before more C-initial than V-initial inflectional suffixes).

As shown in the tableau in (32), the suffix-less, adjectival form [trə́ʃ] not only violates the sonority constraints, but also the requirement of uniformity between paradigm members. Candidate (32a), which represents the actual forms in JTA, violates OP-MAX-V four times. This is because this candidate manifests two ⟨CəCC, CCəC⟩ pairs of paradigm members in which the position of schwa is not uniform. Each of such pairs violates OP-MAX-V twice. Therefore, if the inflections in (31) count as a paradigm, OP fails to generate the correct output.

32

(32) OP fails on the distribution of schwa in JTA adjectives

| /trʃ/ + {a, in}	*ə]$_\sigma$	*CCC	OP-MAX-V	SONCON
a. ☹ ⟨trɔ́ʃ, tərʃá, tərʃín⟩			*!***	*
b. ☞ ⟨tɔ́rʃ, tərʃá, tərʃín⟩				

Recall McCarthy's (2005) stipulation that noun inflections do not constitute a paradigm for the purpose of OP. A similar stipulation for JTA adjectives will not resolve the challenge, differently from the situation with Bobaljik's (2008) Itelmen case study. To see why such a stipulation will not solve the JTA adjectives challenge, consider (33).

(33) OP fails on the distribution of schwa in JTA adjectives (assumption: adjectives have no inflectional paradigm)

/trʃ/	*ə]$_\sigma$	*CCC	OP-MAX-V	SONCON
a. ☹ trəʃ				*!
b. ☞ tərʃ				

If adjectival paradigms consist of only one suffix-less member and the sonority effect on schwa placement is indeed category-independent, the expectation is that the effect would emerge in adjectives as well. However, as can be seen in (33), SONCON favors the wrong candidate (33b) since $C_2 > C_3$ in sonority (r>ʃ). Therefore, regardless of what constitutes a paradigm for JTA adjectives, the distribution of schwa in adjectives contradicts the prediction that category-distinct behaviour is determined by paradigm structure. As summarized in (4) and repeated here in (34), while adjectives behave like verbs phonologically, they contradictory share the paradigm structure of nouns.

(34) A schematic summary of the challenge from Judeo-Tripolitanian Arabic

$$\overbrace{\underbrace{\text{Verb} \quad \underbrace{\text{Adj}}_{} \quad \text{Noun}}_{\text{Paradigm structure}}}^{\text{Phonological behavior}}$$
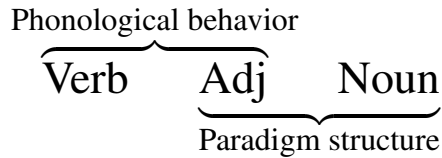
Unlike the previous challenge to OP from Itelmen discussed in section 2.3, the JTA challenge is also unrelated to the problem opacity poses to OT, because the position of schwa is transparent and predictable in each category. The distinct behaviour of schwa across categories therefore cannot be resolved within OP, even by combining the theory with other OT extensions. Accounts of the distribution of schwa in JTA can be easily developed, however, as long as the phonology can make direct reference to categories.

4 Conclusion

We have seen a case study that challenges the original motivation for OP - an analogical theory intended to predict category-distinct behaviour from paradigm structure, rather than by category-specific phonology. Reevaluating one of McCarthy's (2005) core case studies, we have shown that once we consider additional data, the OP analysis breaks down. Our conclusion is therefore that phonology must be able to refer to the categories themselves to explain systematic distinctions between them.

Category-specific effects are of course not the only effects used to argue in favor of a theory with phonological analogy between paradigm members. For example, Kenstowicz (2005) has argued on the basis of different kinds of effects that there is an analogical mechanism that requires *contrast* between paradigm members (i.e., output-to-output constraints that require paradigm members to be sufficiently distinct from one another). Kenstowicz's cases and others should be reexamined as well before determining the fate of the paradigm. Reviewing such cases would have important implications for theoretical morphophonology because, as discussed earlier, they assume a radically different interface of phonology and morphology from the interleaving model that preceded them.

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תקציר

העבודה הזאת בוחנת מחדש הרחבה של תיאוריית האופטימליות הנקראת "פרדיגמות אופטימליות" (Optimal Paradigms, פ"א) שהוצעה על ידי מקארתי (McCarthy 2005). פ"א מניחה שקטגוריות כמו פעלים ושמות עצם לא זמינות לפונולוגיה. במקום השימוש בקטגוריות עצמן, הבדלים שיטתיים בין קטגוריות נגזרים על ידי אילוצים אנלוגיים מיוחדים שדורשים אחידות בין חברים בפרדיגמת נטייה.

אחד ממקרי הבוחן המקוריים שמקארתי (2005) השתמש בהם כדי לטעון לטובת התיאוריה מגיע מערבית מרוקאית. מקארתי הציע שאסימטריה בתפוצת תנועת השווא (schwa) בין פעלים ושמות עצם בערבית מרוקאית ניתנת לחיזוי על ידי פ"א ללא התייחסות ישירה לקטגוריות, באמצעות הפרדיגמות השונות בשפה של פעלים ושמות עצם. בעבודה הזו, אנחנו בוחנים מחדש את ההצעה הזו באמצעות נתונים מערבית טריפוליטאית-יהודית, חברה באותה משפחת השפות של ערבית מרוקאית, השרויה בסכנת הכחדה. אנחנו מראים שאם לוקחים בחשבון לא רק פעלים ושמות עצם, אלא גם שמות תואר, פ"א לא יכולה לחזות את התפוצה של שווא על פני הקטגוריות השונות.

לבחינה האמפירית של פ"א יש השלכות על השאלות התיאוריות הבאות: האם הפונולוגיה רואה קטגוריות כמו פעלים ושמות עצם? האם פרדיגמות הן ישויות דקדוקיות? האם הפונולוגיה יכולה לבצע אנלוגיה? בעוד שתי השאלות האחרונות יישארו פתוחות, אנחנו טוענים שפ"א לא מייתרת את הצורך של הפונולוגיה בהתייחסות ישירה לקטגוריות ומערערים כך על המוטיבציה העיקרית לתיאוריה.

פרדיגמות אופטימליות: אתגר מערבית טריפוליטאית-יהודית

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אפריל 2024