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VOWEL HIATUS AND  
 FAITHFULNESS IN TOHONO  
 O'ODHAM REDUPLICATION  
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## 1 Introduction

The relationship between the base and the reduplicant holds a special place in the current theory of Prosodic Morphology. Within Optimality Theory, correspondence theory (McCarthy and Prince 1995, 1999) uses faithfulness constraints to regulate the relationship between base and reduplicant. Faithfulness relations hold between input-base (IB), base-reduplicant (BR), and input-reduplicant (IR). McCarthy and Prince (1999:232) claim a universal metacondition on ranking “which ensures that faithfulness constraints on the stem domain always dominate those on the affixal domains.” This means that IR faithfulness constraints are always ranked below the other two types. The low ranking of IR faithfulness makes it essentially irrelevant to the model in (1). This Basic Model of reduplication characterizes input-output (IO) faithfulness as IB faithfulness.

- (1) *Basic Model* (McCarthy and Prince 1999:232)
- |         |                 |                           |
|---------|-----------------|---------------------------|
| Input:  | /Af-RED + Stem/ |                           |
|         |                 | ↓↑ <i>IO faithfulness</i> |
| Output: | RED             | ↔                         |
|         |                 | BASE                      |
|         |                 | <i>BR identity</i>        |

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Given this claim, there should be no language that provides evidence to the contrary. However, evidence from Tohono O'odham<sup>1</sup> shows that IO faithfulness is not equivalent to IB faithfulness.<sup>2</sup> IO faithfulness constraints must be evaluated globally over the entire output string. If an input element is present in some part of the output, whether base or reduplicant, then  $\text{MAX}_{\text{IO}}$  is satisfied. In addition, Tohono O'odham provides evidence in favor of a fuller model of reduplication, which allows all possible rankings of the three types of faithfulness, especially a higher ranking of IR faithfulness. The evidence comes from Tohono O'odham reduplication, which tolerates a certain type of vowel hiatus in unreduplicated words, but not in reduplicated words. I show that hiatus resolution requires the high ranking of an IR faithfulness constraint. The analysis of Tohono O'odham reduplication favors the Full Model, pictured in (2), over the Basic Model in (1), as the Full Model allows the free ranking of the three types of faithfulness relations.

(2) *Full Model* (McCarthy and Prince 1999:232)



The analysis advocated here supports the fully symmetric model of correspondence relations in (2), rather than the asymmetric model in (1). Tohono O'odham hiatus resolution has two consequences for the correspondence model of reduplication. First, this analysis argues that IO faithfulness is not equivalent to IB faithfulness. This differs from McCarthy and Prince 1995, where the Basic Model of (1) characterizes the two as equivalent. Second, this analysis disputes the claim that there is a metacondition on ranking, such that stem faithfulness constraints universally outrank affixal faithfulness constraints. The hiatus facts favor a ranking of IR over IB faithfulness constraints.

The squib is organized as follows. In section 2 I introduce the facts of reduplication and vowel hiatus in Tohono O'odham. In section 3 I analyze these facts to motivate the distinction between IO and IB faithfulness, to favor the reduplicative model in (2) rather than the one in (1). In this section I also show that IB and BR faithfulness constraints must rank below IR faithfulness. As a result, affix faithfulness constraints must be allowed to be ranked freely with regard to stem faithfulness constraints.

<sup>1</sup> Tohono O'odham (Papago) is a Uto-Aztecan language spoken in Arizona and Mexico. Sources include Fitzgerald 1997, Mathiot 1973, Saxton, Saxton, and Enos 1989, Zepeda 1988, and the author's fieldwork. (*Sp*) indicates a Spanish loanword. Space constraints limit the data presented.

<sup>2</sup> See also Struijke 1998 on reduplication and Fitzgerald 1998 on accent systems.

## 2 Vowel Hiatus and Syncope in Tohono O'odham

Before looking specifically at cases with vowel sequences, we will examine the pattern of reduplication in words where the initial syllable consists of a short vowel and an optional coda. As illustrated in (3), Tohono O'odham reduplication consists of the prefixation of a light syllable template. The resulting reduplicated word has the shape  $C_1V_2-C_1V_2X$  (where X represents the rest of the word).<sup>3</sup>

(3) *The general pattern of reduplication in Tohono O'odham*<sup>4</sup>

<i>Reduplicated</i>	<i>Unreduplicated</i>	<i>Gloss</i>
gó-gogs	gógs	'dog'
hí-hím	hím	'walking'
ʔú-ʔuwǵ	ʔúwǵ	'woman'
čá-čanjò	čánjò	'monkey (Sp)'

Tohono O'odham has a five-vowel inventory, [i, i, u, o, a], with twenty-five possible permutations. Five of these are identical vowel sequences, represented as long vowels. Thirteen of the remaining twenty possible vowel sequences are attested in Tohono O'odham words: [ia, iu, io, ia, ii, iu, io, ua, ui, oi, oa, ai, au].<sup>5</sup> Sequences are generally tautosyllabic, although some words treat [ia] as belonging to separate syllables.

Vowel sequences do not behave uniformly under reduplication. The asymmetry lies in whether the base contains both of the vowels in the cluster. In (4) the vowel sequences [ia, ii, ia, ui, oi, ai, au] reduplicate only the first vowel, and the base preserves both vowels. The reduplicated word has the form  $C_1V_2-C_1V_2V_3X$ .

(4) *Hiatus preservation and reduplication*

<i>Reduplicated</i>	<i>Unreduplicated</i>	<i>Gloss</i>
ǰí-ǰiawùl	ǰiawùl	'a devil or demon'
ǰí-ǰiid	ǰíid	'seeing'
ǰí-ǰia	ǰía	'look, see'
kú-kui	kúi	'mesquite tree'
hó-hoikà	hóiki	'to move reiteratedly'
dá-daikùḏ	dáikuḏ	'chair'
má-maušć	máušć	'to lock together one's fingers'

However, four vowel clusters, [io, io, oa, ua], act differently in reduplication. These sequences consist of two vowels where the first vowel is higher than the second vowel, and one vowel is [+round].

<sup>3</sup> See Hill and Zepeda 1992 and Fitzgerald 1999 for additional complications.

<sup>4</sup> [l] is a postalveolar lateral flap. [ʃ, dʃ] are apicoalveolar. [č, ʃ] are affricates.

<sup>5</sup> Some research on Tohono O'odham also includes vowel-laryngeal-vowel sequences here. [ii, ui, oi, ai, ou, uo, ao] do not occur, [iu] fails to reduplicate, and [iu] is found only in *hiuʔu* 'yes'.

The forms in (5) show that these vowel sequences are split up under reduplication, with one vowel appearing in the reduplicant and the other in the base. The reduplicated word has the form  $C_1V_2-C_1V_3X$ ; the reduplicant includes the first vowel of the cluster, whereas the base surfaces with just the second vowel. The vowel cluster is systematically avoided in reduplicated words.

(5) *Resolution of hiatus in reduplication*

<i>Reduplicated</i>	<i>Unreduplicated</i>	<i>Gloss</i>
hí-hopčĭg	híopčĭg	'to be full of body lice in one place'
ʔí-ʔoldakùd̥	ʔíoldakùd̥	'bean pot used for frying beans'
čĭ-čoĵ	čoĵ	'boy, man'
ɲí-ɲok	ɲíok	'talking'
dó-da	dóa	'to be healthy'
kó-kawù.l	kóawu.l	'any species or edible fruit of the wolfberry'
čú-čamà	čúama	'roast in ashes'
wú-pandĭ	wúandi	'a glove (Sp)'

The following generalizations hold here. First, the reduplicant contains only one vowel,  $V_2$ . Second, with this type of hiatus in the initial syllable, the base does not contain both input vowels, but instead surfaces with only one vowel,  $V_3$ . A comparison of the base and the reduplicant shows that the reduplicant contains contiguous material ( $C_1V_2$ -BASE), whereas the base 'skips' material (RED- $C_1V_3$ , as opposed to RED- $C_1V_2$ ).<sup>6</sup>

### 3 Hiatus Resolution via Input-Reduplicant Faithfulness

In the previous section I showed that there are two patterns of reduplication for words with vowel sequences. In this section I account for both patterns by showing that IO constraints are not equivalent to IB constraints.  $MAX_{IO}$  must evaluate faithfulness over the entire output, rather than just over the base. I further show that IR faithfulness constraints dominate faithfulness constraints in the IB and BR domains.

The basic pattern of reduplication prefixes a CV reduplicant. A high-ranking templatic constraint (RED =  $\sigma_{CV}$ , after McCarthy and Prince 1994) prefers a light syllable. The base and reduplicant are not completely identical; this fact supports the low ranking of  $MAX_{BR}$ , the faithfulness constraint that regulates BR identity. A low ranking of  $MAX_{BR}$  also predicts that an input vowel cluster results in a reduplicated word of the shape  $C_1V_2-C_1V_2V_3X$ . Tableau (6) shows this result for such a reduplicated word.

<sup>6</sup> See also the few cases with complex onsets: *t.lám̥ba*, *t.lá-lambà* 'tramp (Eng)'.

(6) *Evaluation of /RED-daikuɔ/ 'chair'*

/RED-daikuɔ/	RED <sub>CV</sub>	MAX <sub>BR</sub>
a. dáí-daikùɔ	*!	***
☞ b. dá-daikùɔ		****

The first vowel appears in the reduplicant, and both vowels surface in the base. This is the pattern we expect to surface for most vowel clusters, and so far this hierarchy is sufficient. Vowel clusters with hiatus resolution require additional constraints.

We can compare the unreduplicated word *dóa* 'to be healthy' with its reduplicated counterpart, *dó-da*. Hiatus resolution under reduplication means that a high-ranking constraint against such sequences must outrank faithfulness constraints; otherwise, these vowel sequences would surface in both types of words (a type of "emergence of the unmarked" as in McCarthy and Prince 1994). The proposed constraint, \*HL[+RD], prohibits [+round] vowel clusters when the first vowel is higher than the second.

## (7) \*HL[+RD]

For a sequence  $V_x V_{x+1}$  where one of the two vowels is [+round],  $V_x$  must not be higher than  $V_{x+1}$ .

This constraint is violated by any form meeting the description in (7), regardless of whether the form is reduplicated. Tableau (8) clarifies the role played by \*HL[+RD]. Under a partial evaluation, four candidates appear equally optimal, including the attested output, *dó-da* 'to be healthy'. (Candidates that are incorrectly selected as optimal are marked with \*☞.)

(8) *Partial evaluation of /RED-doa/*

/RED-doa/	RED <sub>CV</sub>	*HL[+RD]
☞ a. dó-da		
*☞ b. dó-do		
*☞ c. dá-da		
*☞ d. dá-do		
e. dóa-doa	*!	**
f. dó-doa		*!

Two candidates are ruled out by these constraints. Output (8e) violates RED<sub>CV</sub>, and (8f) fails because of the proscribed vowel cluster. This leaves (8a–d), which equally satisfy these two constraints by avoiding the dispreferred vowel sequences. Forms (8a–d) are not all equally

faithful; in fact, the actual output, (8a), violates  $MAX_{BR}$  (see tableau (9)). Forms that have identical vowels in the reduplicant and the base fare better on  $MAX_{BR}$ . The fact that such outputs are never attested tells us that  $MAX_{BR}$  is ranked fairly low in the hierarchy, and the violation incurred by (8a) must be balanced by satisfaction of a higher-ranked constraint. Tableau (9) includes only  $MAX$  constraints and evaluates the first three candidates from tableau (8). The outputs equally violate  $MAX_{IB}$  (forcing IB faithfulness) and  $MAX_{IR}$  (forcing IR faithfulness), whereas only one candidate violates  $MAX_{BR}$ .

(9) *MAX constraints and /RED-d<sub>1</sub>o<sub>2</sub>a<sub>3</sub>/ (dó-da ‘to be healthy’ is the actual output)*

/RED-d <sub>1</sub> o <sub>2</sub> a <sub>3</sub> /	$MAX_{BR}$	$MAX_{IB}$	$MAX_{IR}$
a. d <sub>1</sub> ó <sub>2</sub> -d <sub>1</sub> a <sub>3</sub>	*!	*	*
* <sub>IB</sub> b. d <sub>1</sub> ó <sub>2</sub> -d <sub>1</sub> o <sub>2</sub>		*	*
* <sub>IR</sub> c. d <sub>1</sub> á <sub>3</sub> -d <sub>1</sub> a <sub>3</sub>		*	*

The  $MAX$  constraints exclude the optimal (9a). A high ranking of these constraints would incorrectly discard the optimal candidate, suggesting that some other constraint must dominate the  $MAX$  constraints. We must explain why (9a) is the actual optimal form, when (9b–c) both perform better in terms of BR identity because of the identical surface form of base and reduplicant. One important difference is that (9a) actually surfaces with each segment of the input. In contrast, (9b) contains no correspondent of  $a_3$ , and (9c) contains no correspondent of  $o_2$ . Putting aside the issue of reduplication, (9a) is faithful to the input, whereas the other two are not. This is a case of IO faithfulness, rather than correspondence of the base or the reduplicant to either each other or the input.  $MAX_{IO}$  must be ranked high to avoid deleting an input element from the output.

(10)  $MAX_{IO}$  (McCarthy and Prince 1995:264)

Every segment of the input has a correspondent in the output.

$MAX_{IO}$  cannot be limited to IB faithfulness, as in McCarthy and Prince 1995.<sup>7</sup> The data presented here show that  $MAX_{IO}$  evaluates a fourth dimension of faithfulness, a more global evaluation, together with  $MAX_{IR}$ ,  $MAX_{IB}$ , and  $MAX_{BR}$ . The evidence for this comes from the preferred pairing of input /RED-d<sub>1</sub>o<sub>2</sub>a<sub>3</sub>/ with the attested output d<sub>1</sub>ó<sub>2</sub>-d<sub>1</sub>a<sub>3</sub> over the unattested \*d<sub>1</sub>ó<sub>2</sub>-d<sub>1</sub>o<sub>2</sub>.

<sup>7</sup> See the behavior of  $DEP_{IO}$  in tableau (24) in McCarthy and Prince 1995: 277.

Furthermore,  $MAX_{IO}$  must dominate  $*HL[+RD]$  to preserve the marked sequences in unreduplicated words.<sup>8</sup> Tableau (11) reevaluates the forms from tableau (9).  $MAX_{IO}$  plays a critical role in rejecting both (11b–c) because some input segments are not present anywhere. In contrast, (11a) satisfies  $MAX_{IO}$  because each indexed element of the input surfaces somewhere in the output.

(11) *Partial evaluation of /RED-d<sub>1</sub>o<sub>2</sub>a<sub>3</sub>/*

/RED-d <sub>1</sub> o <sub>2</sub> a <sub>3</sub> /	RED <sub>CV</sub>	MAX <sub>IO</sub>	*HL[+RD]
☞ a. d <sub>1</sub> o <sub>2</sub> -d <sub>1</sub> a <sub>3</sub>			
b. d <sub>1</sub> o <sub>2</sub> -d <sub>1</sub> o <sub>2</sub>		*!	
c. d <sub>1</sub> a <sub>3</sub> -d <sub>1</sub> a <sub>3</sub>		*!	

The preference for (11a) over the other two candidates supports the move to a global evaluation by  $MAX_{IO}$  and the separation of  $MAX_{IO}$  and  $MAX_{IB}$ . However, there is a remaining candidate that we must still exclude,  $*d_1a_3-d_1o_2$ . This form has a noncontiguous string in the reduplicant (RED = C<sub>1</sub>V<sub>3</sub>) and contiguous elements in the base (BASE = C<sub>1</sub>V<sub>2</sub>). In contrast, the optimal candidate (11a) has contiguous elements in the reduplicant (RED = C<sub>1</sub>V<sub>2</sub>) and noncontiguous elements in the base (BASE = C<sub>1</sub>V<sub>3</sub>). The key is that in the reduplicant the elements occur in the same order as in the input, but in the base V<sub>2</sub> is skipped. The relevant constraint is CONTIGUITY, a faithfulness constraint that rules out skipped elements (McCarthy and Prince 1995: 371). Skipped elements are tolerated only in the base; thus, CONTIG<sub>IR</sub> outranks CONTIG<sub>IB</sub>.

(12) a. *CONTIGUITY<sub>IR</sub>*

The portion of the reduplicant standing in correspondence to the input forms a contiguous string.<sup>9</sup>

<sup>8</sup> This point is demonstrated in tableau (i) for the unreduplicated word *sibio* 'hoe'.

(i) *MAX<sub>IO</sub> and \*HL[+RD] in the evaluation of /sibio/*

/s <sub>1</sub> i <sub>2</sub> b <sub>3</sub> i <sub>4</sub> o <sub>5</sub> /	RED <sub>CV</sub>	MAX <sub>IO</sub>	*HL[+RD]	CONTIG <sub>IR</sub>	CONTIG <sub>IB</sub>
☞ a. s <sub>1</sub> i <sub>2</sub> b <sub>3</sub> i <sub>4</sub> o <sub>5</sub>			*		
b. s <sub>1</sub> i <sub>2</sub> b <sub>3</sub> i <sub>4</sub>		*!			
c. s <sub>1</sub> i <sub>2</sub> b <sub>3</sub> o <sub>5</sub>		*!			

<sup>9</sup> An anonymous reviewer suggests an alternative using positional faithfulness of the word-initial syllable (following Steriade 1993, Beckman 1997,

b. *CONTIGUITY<sub>IB</sub>*

The portion of the base standing in correspondence to the input forms a contiguous string.

The hierarchy in tableau (13) includes these two faithfulness constraints, plus *RED<sub>CV</sub>* and *\*HL[+RD]*. The attested *dó-da* ‘to be healthy’ violates the lower-ranked *CONTIG<sub>IB</sub>*, whereas the unattested candidate (13b) fails by virtue of violating the higher-ranked *CONTIG<sub>IR</sub>*.

(13) *Reevaluation of /RED-d<sub>1</sub>o<sub>2</sub>a<sub>3</sub>/*

/RED-d <sub>1</sub> o <sub>2</sub> a <sub>3</sub> /	<i>RED<sub>CV</sub></i>	<i>MAX<sub>IO</sub></i>	<i>*HL[+RD]</i>	<i>CONTIG<sub>IR</sub></i>	<i>CONTIG<sub>IB</sub></i>
☞ a. d <sub>1</sub> ó <sub>2</sub> -d <sub>1</sub> a <sub>3</sub>					*
b. d <sub>1</sub> á <sub>3</sub> -d <sub>1</sub> o <sub>2</sub>				*!	

This tableau shows that *IR* constraints must dominate *IB* constraints to account for hiatus resolution in Tohono O’odham reduplication. This ranking makes the correct predictions for longer words, too. Tableau (14) demonstrates this for a longer form and includes a candidate that has unforced violations of *MAX<sub>IO</sub>*.

(14) *Evaluation of /RED-č<sub>1</sub>ú<sub>2</sub>a<sub>3</sub>m<sub>4</sub>a<sub>5</sub>/*

/RED-č <sub>1</sub> ú <sub>2</sub> a <sub>3</sub> m <sub>4</sub> a <sub>5</sub> /	<i>RED<sub>CV</sub></i>	<i>MAX<sub>IO</sub></i>	<i>*HL[+RD]</i>	<i>CONTIG<sub>IR</sub></i>	<i>CONTIG<sub>IB</sub></i>
a. č <sub>1</sub> ú <sub>2</sub> -č <sub>1</sub> u <sub>2</sub> a <sub>3</sub> m <sub>4</sub> à <sub>5</sub>			*!		
☞ b. č <sub>1</sub> ú <sub>2</sub> -č <sub>1</sub> a <sub>3</sub> m <sub>4</sub> à <sub>5</sub>					*
c. č <sub>1</sub> ú <sub>2</sub> -č <sub>1</sub> a <sub>3</sub> m <sub>4</sub>		*!			*

*\*HL[+RD]* is fatally violated by (14a) because the base surfaces with one of the proscribed vowel sequences. The winning form, (14b), breaks up the sequence without violating *MAX<sub>IO</sub>* or *CONTIG<sub>IR</sub>*, but incurs a nonfatal violation of the low-ranked *CONTIG<sub>IB</sub>*. Finally, candidate (14c) both resolves hiatus and deletes the final vowel, showing that excessive violations of *MAX<sub>IO</sub>* will always be fatal.

and Dresher and van der Hulst 1998). This replaces *CONTIG<sub>IR</sub>* with *CONTIG<sub>σ1</sub>*. There are at least three reasons why such an account fails. First, the marked vowel sequences appear in noninitial syllables, even after the same initial vowel, as in *sibio* ‘hoe’ or *čúrwua* ‘to reach puberty (female)’. This favors an analysis that invokes reduplicative faithfulness. Second, morphological truncation in Tohono O’odham deletes medial glottals, resulting in noncontiguous initial syllables: *h<sub>1</sub>ú<sub>2</sub>ʔ<sub>3</sub>a<sub>4</sub>* (base), *h<sub>1</sub>ú<sub>2</sub>a<sub>4</sub>* (truncated word) ‘raking together’. Third, there are reduplicated words that undergo syncope in the base, if the resulting coda is well formed (Fitzgerald 1999). Such cases may have a noncontiguous initial syllable (but a contiguous reduplicant), as in the following monosyllable (*s* = is a stative clitic): *s = d<sub>1</sub>á<sub>2</sub>p<sub>3</sub>k<sub>4</sub>*, *s = d<sub>1</sub>á<sub>2</sub>-d<sub>1</sub>p<sub>3</sub>k<sub>4</sub>* ‘pressing down with fingers repeatedly’. All three examples are problematic for the *CONTIG<sub>σ1</sub>* alternative.



#### 4 Conclusion

In this squib I have shown that hiatus surfaces in unreduplicated words, giving evidence that hiatus is tolerated in such forms. However, in reduplicated forms hiatus is resolved in four of the possible vowel clusters [io, io, ua, oa], such that the cluster does not appear in either the base or the reduplicant. Rather, the cluster is broken up so that  $V_2$  surfaces in the reduplicant and  $V_3$  in the base. This means that only the reduplicant contains contiguous input material. It also shows that IO faithfulness must hold over the entire string because the base and reduplicant do not each preserve the same material. The resolution of certain  $V_2V_3$  sequences supports the presence of an antih hiatus constraint that is active in reduplicated words. Additionally, the reduplicant contiguity constraint must dominate the base contiguity constraint ( $\text{CONTIG}_{\text{IR}} \gg \text{CONTIG}_{\text{IB}}$ ), and MAX constraints on reduplication must be ranked relatively low. In this pattern of hiatus resolution the reduplicant is more faithful to the input than the base is. As a result, IR faithfulness constraints must dominate IB faithfulness constraints. This has been argued to be universally avoided (McCarthy and Prince 1995, 1999); the arguments presented here thus provide evidence that such a universal ranking cannot be the case. Finally, the analysis distinguishes between  $\text{MAX}_{\text{IO}}$  (which evaluates the input string against the entire output string) and  $\text{MAX}_{\text{IB}}$  (which evaluates the input string only against the base), showing that these are not equivalent.  $\text{MAX}_{\text{IO}}$  must evaluate IO faithfulness globally over the entire output string, rather than restricting the evaluation to only one of the morphemes in a reduplicated word. The interaction of vowel hiatus and reduplication in Tohono O'odham supports these modifications to correspondence relations for reduplicated words.

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NONCYCLIC OPERATIONS AND THE  
LCA IN A DERIVATIONAL  
THEORY

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In *A Derivational Approach to Syntactic Relations (DASR)*, Epstein et al. (1998) present a derivational theory of syntax incorporating no levels of representation. The aim of *DASR* is to “advance the hypothesis that the structure building rules Merge and Move (Chomsky 1994) naturally express all syntactically significant relations” (*DASR*:3). Chapter 5 of *DASR* deduces the ill-formedness of noncyclic concatenation from assumptions needed independently to maintain such an approach to syntactic relations. However, another section of *DASR* (section 2.4) presents a derivational analysis of several binding phenomena that relies crucially on the noncyclic application of Merge. Thus, *DASR* appears to make contradictory assumptions. In section 1 I review *DASR*’s deduction of the ill-formedness of noncyclic applications of concatenation, discussing the Merge/Move algorithm and Kayne’s (1994) Linear Correspondence Axiom (LCA) in turn. In section 2 I examine some binding phenomena and the *DASR* account of them. In section 3 I clarify the incompatibility between the *DASR* account of

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