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Persian Morphosyntactic Features in Realization Optimality Theory

Abstract
Realization Optimality Theory is a recent development in the original Optimality Theory which is proposed to deal with morphological issues especially the inflectional ones. Its main idea is to consider the morphological realization rules as ranked violable language-specific constraints which control the realization processes and provide phonological information of grammatical morphemes. This article deals with the investigation of some morphosyntactic (inflectional) features of Modern Persian in Realization Optimality Theory, and shows among the other things that it is a better model for treating inflection than the original Optimality Theory, but it still faces some problems with regard to a language like Modern Persian in which some morphosyntactic features are treated differently in formal and informal varieties, hence separate tableaux with different rankings of constraints are sometimes needed in order to select the optimal candidates in each of those varieties.

Key words: Optimality Theory, Realization Optimality Theory, constraint, realization constraint, inflection, morphosyntactic feature

1. Introduction

Optimality Theory (OT) is a constraint-based model proposed by Prince and Smolensky in 1993. It was originally developed to deal with phonological issues, but its basic ideas are used in other domains of linguistics such as syntax (Grimshaw 1997) and morphology (Wunderlich 2001, Albright 2008) as well. The model is based on the assumption that there are some universal constraints in all the languages of the world which are ranked differently according to their importance in each language. These constraints can conflict with each other and can be violated under certain conditions, and the differences between languages are due to the different rankings of them (Wunderlich 2006: 408). In recent years we can see OT approach being generalized in morphological studies (Bauer 2003: 227) and there have been some efforts to explain morphological phenomena such as reduplication, blocking, morphological gaps, and inflection adopting OT framework.

There have been some efforts to modify and develop the original version of OT so that it can fulfill a wider range of morphological phenomena. One of those efforts in the domain of Inflection is Realization Optimality Theory (Realization OT) (Xu 2007, Aronoff & Xu 2010), Which is an inferential-realizational model and considers morphological realization rules as violable constraints in Optimality framework. This model is inferential in that an affix is not a lexical entry by itself, but is introduced by a grammatical function, which is a constraint here, and it is realizational in that affixation is licensed by abstract morphosyntactic feature values (Xu 2007: 3). This model traces back to Russell 1995 who believes that OT would be theoretically simpler and more adequate if we treat morphemes as constraint (Russell 1985:2). Therefore, the phonological realization of morphemes, the morphs, can be introduced through language-specific morphemic constraints (Bonet 2004: 74).In Realization OT the phonological information of inflectional elements is realized through realization constraints (RCs) which associate

morphosyntactic feature values with phonological forms (Aronoff & Xu 2010: 382).

This article is devoted to investigation of some inflectional properties of Modern Persian in Realization OT framework. Meanwhile, after a short introduction to OT and Realization OT, morphosyntactic properties of plurality, definiteness, and possession for nouns, and tense, aspect, and agreement for verbs in Persian will be explained.

2. A short review of OT and Realization OT

OT is based on the assumption that the structure of the grammar is determined by a set of ranked violable universal constraints rather than ordered rules. Here instead of levels of derivation, we see the correspondence between inputs and outputs. There is a tension between two types of constraints namely faithfulness and markedness constraints which compete to provide optimal output candidate (Katamba & Stonham 2006: 205). The faithfulness constraints are of two main types: "dependence constraints" which prohibit the occurrence of elements or features in the output that do not have a correspondent in the input, and "maximality constraints" which prohibit the presence of elements or features in the input that do not have a correspondent in the output (Wunderlich 2006: 409). Linear ordering in the output (whether a consonant cluster is possible in the onset, for example) are mostly of markedness type. In this model after the formation of all possible outputs by "Genarator" (Gen), the optimal form(s) will be selected according to the filtering function of "Evaluator" which is the ranking of specific constraints (McCarthy 2008: 19).

The functions of Generator and Evaluator are represented by the use of the tableaux in the top left-hand corner of which is the input, with the possible outputs in separate rows below it. The constraints are ranked in the topmost column from left to right, according to their importance in the language. Violations of the constraints are indicated by <*>, but the most serious violations, the fatal ones, are indicated by <!>. the optimal output candidate is marked by <☞> (Katamba & Stonham 2006: 206):

Input	Constraint 1	Constraint 2	Constraint 3
Output 1	*!		
☞ Output 2			*
Output 3		*!	
etc			

The optimal output should be the one which has not violated any constraints or has violated the less important one(s). A dashed line between the constraints means that there is no priority in their ranking.

In Realization OT on the other hand, the morphological realization rules will be considered as ranked violable constraints as well, hence a new set of language-specific constraints will be introduced under the name

of Realization Constraints (RCs) which control the realization processes and provide phonological information of grammatical morphemes. The basic format of these constraints is the following one (Xu & Aronoff 2011: 679):

{morphosyntactic feature}:{morphophonological form}

It means the realization process creates the relation between abstract morphosyntactic features and morphophonological forms. For instance the realization constraint {pl}:-z in English will be interpreted as "the abstract feature of plurality will be realized by the suffix –z (Aronoff & Xu 2010:389).

In the contrary to original OT, according to which the constraints are considered to be universal, in Realization OT realization constraints are language-specific, but they are instantiations of universal constraints that associate meaning with form (ibid: 391-392).

3. Modern Persian Inflectional Properties in Realization OT

Typologically speaking, modern Persian is not an inflectional language anymore, but it still has some inflectional (morphosyntactic) features realized in its nouns, verbs, adjectives and adverbs (for a more detailed discussion of these features c.f. Ghatreh 2008: 52-81). The realization of some of those features is different in spoken (informal) and written (formal) varieties of Persian, which sometimes leads to different ranking of constraints. Besides, the possibility of multiple affixation puts forward the question of affix ordering which can be replied in Realization OT. These and some other topics are discussed in the rest of this article.

3.1. Plurality in Persian Nouns

In Modern Persian, nouns are inflected for plurality usually by the means of inflectional suffixes *-ha* and *–an.* The suffixation of *–an* is limited to [+animate] nouns or those things referring or belonging to [+animate] nouns[1], but *–ha* can be added to all types of nouns in every possible context. We can show the distribution of these two suffixes by means of the following realization constraints:

1. {pl}: -ha
2. {pl/+ animate}: -an

Realization constraint 1 means that for realizing the feature plurality the suffix *–ha* will be added, and according to the realization constraint 2 nouns having the feature [+animate] can become plural by adding the suffix *–an* as well. In other words, the morphosyntactic property of plurality in [+animate] nouns can be realized either by suffixation of *–ha* or by *–an*:

3. pes□r.ha (boys)
4. pes□r.an (boys)

[1] . The plural form of some [+animate] nouns is formed just by suffixation of –ha: b□čče.ha (babies), but *b□čče.g.an.

of course there is a stylistic difference between the two forms, according to which the form having *–an* is used in more formal (usually written) variety of Persian (Ghatreh 2011:97).

In Realization OT, all the required grammatical information for selecting the optimal form is included in the tableaux in the form of realization constraints. The point is that if we use a single tableau for both formal and informal varieties of Persian, the number of optimal candidates will be increased, without being able to distinguish them according to their stylistic differences[1]:

5. plural form of pes□r[2]

pes□r,pl	ONSET	{pl/+animate}:-an	{pl}:-ha	MAX IO
pes□r.an	*!		*	
☞pes□.ran			*	
☞pes□r.ha		*		
pes□r.a	*!	*		*
☞pes□.ra		*		*

ONSET is a markedness constraint according to which no syllable can be left without onset, and its violation is fatal in Persian (Modarresi Ghavami 2011: 5).

Now, if we use separate tableaux for each of the two varieties, the problem will be solved:

6. formal plural of pes□r: -an

pes□r,pl,animate	ONSET	{pl/+animate}:-an	MAX IO
pes□r.an	*!		
☞pes□.ran			
pes□r.ha[3]		*!	
pes□r.a	*!	*	*
pes□.ra		*	

7. informal plural of pes□r: -ha

pes□r,pl	ONSET	{pl}:-ha	MAX IO
pes□r.an	*!	*!	
pes□.ran		*!	
☞pes□r.ha			
pes□r.a	*!		*
☞pes□.ra			*

As we can see, there are two optimal forms for plural in informal (spoken) variety of Persian. In situations like this where two or more forms can be used as free variations whose selection is due to stylistic rather than grammatical reasons, we could speak either of parallel co-phonologies (different parallel phonological

[1].for ranking the realization constraints we can use Panini's Principle (Xu 2007:79) which gives the priority to more restricted one ({pl/+animate}: -an).

[2] . In all the examples "–"shows the morpheme boundary and "." shows the syllable boundary.

[3] . The plural suffix –ha is in fact the default element which can be used both in formal and informal varieties.

systems) in a single language, or of free ranking of constraints (Kager 1999: 404-406)[1].

The suffix *–a* is the allomorph of *–ha* which is formed by deletion of "*h*" and is used in informal speech with the nouns ending in consonants; but if the nouns end in vowels "*h*" can't be omitted (e.g. mu.ha (hair)). In this case the constraints will have a different ranking to be able to select the optimal candidate appropriately:

8. plural form of mu:

mu, pl	*VV	ONSET	{pl}: -ha	MAX IO
☞ mu.ha				
mu.a	*!	*!		*

There is a less common third type of plural suffix in Persian borrowed from Arabic whose context is limited to some Arabic nouns, but is also used with a few Persian nouns (such as sefareš (order), pišn□had (suggestion), baG (garden), and deh (village) as well:

9. sefareš → sefareš-ha/ sefareš-ha
10. pišn□had → pišn□had-ha/pišn□had-at
11. baG → baG-ha/ baG-at
12. deh → deh-(h)[2]a/ deh-at/ deh-at-ha

As it is seen, in "deh-at-ha" both –at and –ha are added to the singular noun "deh". But according to the markedness constraint of *FEATURE SPLIT (*FS) (XU 2007: 6, Xu & Aronoff 2011: 674) the value of each morphosyntactic property should not be realized by more than one phonological form. In other words, two or more elements cannot be added to realize a single feature simultaneously. The violation of *FS will lead to ungrammatical forms, and that is why the forms such as "*oxens" are ungrammatical (Xu 2007: 81):

input: ox ,pl ox	{pl/ ox}: -en	*FS	{pl}: -s
☞ a. ox ,pl oxen			*
b. ox ,pl oxen -s		*!	
c. ox ,pl ox -s	*!		

But in the case of "*deh-at-(h)a*" the situation is different, and the suffix *–at* is not functioning as the plural marker, but it is considered as part of the stem, to which the suffix *–(h)a* can be added. In other words, the native speakers of Persian consider "*dehat*" a singular word without any plural suffix, hence they use it in a sentence like the following:

13. Ali r□ft dehat -ešun.
    Ali go/past village-their

[1]. But the problem arises when there are no stylistic differences either. See section 3.4 in this article.

[2]. The parenthesis is used to show the optional segment.

Ali went to their village.

That is why "*dehat*" can become plural by suffixation of *–(h)a*, and can undergo the derivational suffixation of *-i* to form derived adjective "*dehat-i*" (villager).

There is another point with regard to the suffix *–at*: in some words ending in vowel /e/ such as "*kore*" (planet), "*s□jjare*" (planet), and "*n□z□rije*" (theory), the final vowel of the stem will be omitted before the suffixation of –at, hence leading to the following plural forms:

14. kor-at
15. s□jjar-at
16. n□z□rij-at

the reason is to avoid the violation of *VV constraint which prevents the cooccurrence of two adjacent vowels.[1] The solution is either deletion of one of those adjacent vowels, or the insertion of a consonant between them. And as it is seen the former solution is chosen in the case of *kor-at*,*s□jjar-at*, and *n□z□rij-at*:

17. plural form of "kore":

kore,pl	*VV	ONSET	{pl/kore}: -at	DEP IO	MAX IO
kore.at	*!	*!			
kore.t					*
kor.at		*!			
☞ko.rat					
kore.□at				*	

The problem of violation of *VV in Persian is solved in a different way in some other words, by insertion of a consonant between the two adjacent vowels. For instance, in case of suffixation of plural suffix –an, if the stem ends in vowel /e/ the consonant /g/ will be inserted befor it, and if the final vowel of the stem is /a/, /i/, or /u/ usually the inserted consonant is /j/[2] :

18. p□r□nde → p□r□nde-g-an
bird - c[3] –pl
(birds)

19. □aGa → □aGa -j-an
gentleman-c-pl
(gentlemen)

In order to explain such forms in Realization OT we can propose the following constraints:

20. {pl/+animate}: -an
21. *VV
22. ONSET
23. MAX IO
24. DEP IO

The following tableau shows the ranking of these constraints to predict the optimal plural form of □aGa:

25. The plural form of "□aGa" (formal):

□aGa,pl	*VV	ONSET	{pl/+animate}:-an	MAX IO	DEP IO

[1] . That is why h in plural suffix –ha can't be omitted when the noun ends in vowel.

[2] . In a few other words /k/ or /v/ will be inserted to avoid vowel hiatus. There are synchronic and diachronic reasons for the selection of these consonants which is irrelevant to our present discussion. (c.f. Shaghaghi 2007: 75-77).

[3] . c stands for consonant.

□aɢa.an	*!	*!			
□aɢa.n				*	
□aɢaj. an		*!			*
☞□aɢa.jan					*

The model correctly predicts that the optimal candidate is "aɢa.jan" because it only violates the less important DEP IO constraint which prevents the insertion of an element in the output which has no correspondence in the input.

Of course it is not the case that DEP IO is always the least important constraint in Persian, but as we saw in 17 it has a higher ranking than MAX IO. In fact they are the morphophonological data of the language which determine different rankings of the constraints.

3.2. Possessive clitics in Persian and *VV constraint

There are some personal clitics in Persian which show possession:

Person / Num.	singular		plural	
	formal	informal[1]	formal	informal
1st	-□m	-□m	-eman	-emun
2nd	-□t	-et	-etan	-etun
3rd	-□š	-eš	-ešan	-ešun

As we can see, all of these clitics begin with a vowel, and the problem of vowel hiatus will arise when they attach to the words ending in vowel. There are two different solutions to avoid the violation of *VV in formal (written) and informal (spoken) varieties, which lead to different rankings of the constraints. In formal (written) Persian the insertion of a consonant prevents the violation of *VV; usually this consonant is /j/ except for the insertion of singular clitics to the words ending in /e/ that the inserted consonant will be /□/:

26. seda -j-□m
    voice –c -poss (1st,sing)
    (my voice)

27. mahi-j-ešan
    fish–c-poss (3rd ,pl)
    (their fish)

28. b□čče-j-eman
    baby – c- poss (1st,pl)
    (our baby)

29. b□čče-□-□m
    baby – c-poss (1st,sing)
    (my baby)

We can see the ranking of the constraints in the following tableau in which MAX IO outranks DEP IO:

30. "sedajam" (formal):

seda,poss,1st, sing	*VV	ONSET	{poss,1st,sing}: -□m	MAX IO	DEP IO

[1]. For the words ending in /e/ there is no difference between formal and informal forms of singular clitics: x□nd□m (my laughter), nam□t (your letter).

seda.□m	*!	*!			
☞seda.j□m					*
sedaj.□m		*!			*
seda.m				*	

In informal (spoken) Persian on the other hand, one of the two adjacent vowels will be omitted in order not to violate *VV constraint; sometimes this omitted vowel is the final vowel of the host, and sometimes it is the vowel of the clitic:

31. xande + -□m → xand-□m
    laughter-poss(1st, sing)
    my laughter

32. seda + -□m → seda-m
    voice –poss (1st , sing)
    my voice

Because of the vowel deletion, here DEP IO outranks MAX IO:

33. "sedam" (informal):

seda,poss,1st,sing	*VV	ONSET	{poss,1st sing}: -□m	DEP IO	MAX IO
seda.□m	*!	*!			
seda.j□m				*	
sedaj.□m		*!		*	
☞seda.m					*

Here again if we don't use separate tableaux for formal and informal Persian the theory can't predict the appropriate candidate because there will be more than one optimal form.

3.3. Different behavior of Inflectional and Derivational elements towards *VV constraint

The vowel deletion for avoiding vowel hiatus in spoken Persian only occurs when we have inflectional suffixes and clitics. But in derivational morphology when a derivational suffix beginning with a vowel is added to a word ending in a vowel, the consonant /j/ will be inserted not to avoid *VV constraint:

34. s□rma + -eš → s□rma-j-eš / * s□rma.š
    coldness- der[1]

35. g□rma +-eš → g□rma-j-eš / * g□rma.š
    warmth - der

In other words, there is no difference between informal (spoken) and formal (written) Persian in selecting optimal candidates in case of derivational suffixes, hence no need to have separate tableaux:

36. "s□rmaješ""

s□rma, eš	*VV	ONSET	MAX IO	DEP IO
s□rma.eš	*!	*!		
☞ s□rma.ješ				*
s□rmaj.eš		*!		
s□rma.š			*	

[1]. "der" stands for derivational.

Another difference in the behavior of inflectional and derivational elements against vowel hiatus is the insertion of different consonants to avoid the violation of *VV constraint. There is a derivational suffix –i in Persian which can form nouns from adjectives:[1]

37. $xub_{(Adj)}$ +-i → $xubi_{(N)}$
good being good

This suffix is homophonous with the indefinite clitic "i". when the derivational suffix –i is added to the adjectives ending in /e/, the inserted consonant to avoid vowel hiatus will always be /g/:[2]

38. –i suffixation:

	adjective	-i suffixation
a.	tire (dark)	tire-g-i (darkness)
b.	kohne (old)	kohne-g-i (oldness)
c.	sade (easy)	sade-g-i (easiness)

But in order for the *vv constraint not to be violated in the case of cliticization of indefinite "i" to the same words, /j/ will be inserted:

39. –i cliticization:

	adjective	-i cliticization
a.	tire (dark)	r□ng-e tire-j-i color-gen[3] dark-c-indef[4] (a dark color)
b.	kohne (old)	lebas-e kohne-j-i dress-gen old-c-indef (an old dress)
c.	sade (easy)	porseš-e sade-j-i question-gen easy-c-indef (an easy question)

As we saw the selection of the consonant to be inserted to avoid vowel hiatus depends on the type of the morphological element added to the base. It is a clear instance of the interaction of morphology and phonology in Persian.The following tableaux can be proposed for prediction of the optimal candidate in each case:

40. "sadegi" (derivational suffixation):

sade,der suf	*VV	ONSET	DEP IO
sade. i	*!	*!	
☞ sade.gi			*
sadeg.i		*!	*

41. "sadeji" (cliticization):

sade,inf. cl.	*VV	ONSET	DEP IO
sade.i	*!	*!	
☞ sade.ji			*
sadej.i		*!	*

Of course there is no difference between them in the type or ranking of the constraints, but we can't have a single tableau for them either, because there will be more than one candidate

[1] It can be added to the nouns to form adjectives as well, but it is irrelevant to the present discussion.
[2]. There is a diachronic reason for the occurance of /g/ here which we don't get into its discussion.
[3]. "gen" stands for genitive
[4] . "indef" stands for indefinite.

with no explanation about their distinction in their usage:

42. "sade-i":

sade, i	*VV	ONSET	DEP IO
sade.i	*!	*!	
☞ sade.ji			*
sadej.i		*!	*
☞ sade.gi			*
sadeg.i		*!	*

Those who consider these inserted consonants as morphemes can introduce some realization constraints to explain their distribution, but it is not possible for those who consider them as phonemes.

3.4. Persian Definite Markers and Different Optimal Forms

One serious problem arises when there are more than one optimal candidate whose selection has no apparent grammatical or stylistic reasons, hence even the separate tableaux will be of no help. Such a situation exists in realization of the morphosyntactic feature of definiteness in informal (spoken) Persian. In this variety of Persian the feature of definiteness in nouns is realized either by inflectional suffix *–e*, or by clitic *–eš*, or by no overt marker:

43. film-e xub bud.
film-def[1] good was (The film was good.)

44. film-eš xub bud.
film-def good was(The film was good.)

45. film xub bud.
film(def) good was(The film was good.)

46. film,def (informal):

film, def	ONSET	{def}:-e	{def}: -eš
film.e	*!		*
☞ fil.me			*
film.eš	*!	*	
☞ fil.meš		*	
☞ film		*	*

Because Realization OT follows the idea of Natural Morphology (Wurzel 1989) according to which the ideal unmarked situation is the one in which one meaning corresponds to one form, it is not optimal to have empty morph or zero allomorph in outputs. Therefore a form like "film" cannot be the optimal candidate because there is no overt marker for realizing definiteness in it, but it is used as a grammatical optimal form in Persian which carries the morphosyntactic feature of definiteness. This is a point which is remained unexplained in Realization OT.

Another point about the definite markers in informal (spoken) Persian is that definite suffix *–e* can just be added to the singular nouns,

[1]. "def" stands for definite.

whereas definite clitic *–eš* can be added to the plural nouns as well; thus if a plural noun is going to be marked for the morphosyntactic feature of definiteness, the only overt marker will be the clitic *–eš* :[1]

47. "filmha, def (informal):

filmha, def	*VV	ONSET	{def/pl}: -eš	DEP IO	MAX IO
film.ha.e	*!	*!	*		
film.ha.□e			*	*	
film.ha.eš	*!	*!			
☞film.ha. š					*
film.ha. □eš				*	

Because in Persian informal speech to avoid the violation of vowel hiatus the segment deletion is prior to the consonant insertion, DEP IO outranks MAX IO, and the optimal candidate will be "filmhaš".

3.5. Agreement and *Feature Fusion in Persian Verbs

Persian verbs inflect for morphosyntactic features of person and number, to show the agreement with their subjects. Both of these features are realized in the verbs by a single portmanteau morph, an inflectional suffix. Whenever such a thing happens the markedness constraint of *FEATURE FUSION is violated. According to this constraint a phonological form cannot realize more than one morphosyntactic feature (Xu 2007:6). But the violation of this constraint doesn't necessarily prevent a given form to be the optimal one (ibid: 16). That is why in Persian verbs the optimal form can be the one in which one single morph is realizing two morphosyntactic features of person and number:

48. m□n r□f-t-□m
I go-past-1st,sing (I went)

But in the past tense of the Persian verbs there is not even a single morph to realize the two features of third person and singular, and they have no overt realization at all (or they are realized by a zero morph):

49. Ali r□f-t-Ø
Ali go-past-3rd ,sing (Ali went)

In informal speech on the other hand there is a second option too, and the features of third person and singular can be realized by suffixation of –eš:

50. Ali r□f-t-eš
Ali go-past-3rd,sing (Ali went)

[1]. Of course plural nouns like singular nouns can be definite with no overt marker too: film-ha xub bud□nd.

Here again more than a single optimal candidate exists, and one of them (r□ft) has violated two realization constraints:

51. r□ft (3rd, sing) (informal):

r□ft,3rd,sing	ONSET	{3rd,sing}: -eš	{3rd,sing}: Ø
r□ft.eš	*!		*
☞ r□f.teš			*
☞ r□ft		*	*

According to Stump (2001:256) if a single slot in an inflectional paradigm can be filled by two different members, we have "doublets". Sometimes the distribution of the doublets can be explained by some discoursal or stylistic reasons, but sometimes there are no such reasons, and in this case the tableaux in Realization OT cannot select a single optimal candidate.

3.6. Aspect, Voice, and *FEATURE SPLIT in Persian Verbs

As it was mentioned in section 3.1, *FEATURE SPLIT is a markedness constraint which prevents the realization of a single morphosyntactic feature by more than a single form.

*FEATURE SPLIT like *FEATURE FUSION is more appropriate for agglutinative languages where there is a one to onecorrespondence between morphosyntactic features and forms. But in a language like Persian it may be violated under certain conditions. For instance in formal variety of Persian, perfective aspect in present tense is realized in verbs by means of two morphemes simultaneously: the suffix –e and a clitic:

52. xor-d-e-□□m
eat-past-perf[1]-perf,1st,sing (I have eaten)

of course we can see the violation of *FEATURE FUSION here as well, because the clitic - □□m is realizing aspect, person and number at the same time.

53. xor –d –e -□□m
stem past perf 1st sing

Another instance of violation of *FEATURE SPLIT in Persian is seen in realization of passive voice by means of the suffix –e and the verb "šod□n":

54. xord-e šod -□nd
ate- pass[2] pass- 3rd, sing

here again we see the violation of *FEATURE SPLIT and *FEATURE FUSION at the same time:

55. xord -e šo-d -□nd
stem pass past 3rd pl

The fact that despite of the violation of these two constraints the related forms are still grammatical, leads to the conclusion that they don't have a higher ranking in Persian.

3.7. Affix Ordering in Realization OT

In recent years there has been a considerable interest in multiple affixation and in explaining the order of affixes in a single base (Hyman

[1]. "perf" stands for perfective aspect

[2]. "pass" stands for passive.

2002:245). Of all possible affix combinations in a language, a relatively limited number really exist which gives rise to the question of what principle(s) is/are responsible for the combination of affixes (Manova & Aronoff 2010: 109). Bybee 1985 believes in some semantic reasons for order of affixes and suggests that those affixes having greater "relevance" to the action of the verb root appear closer to it. She believes that it is a suitable explanation for inflectional affixes (1985:34).Baker (1985) on the other hand proposes the "Mirror Principle" according to which affix orders directly correlate with the order of syntactic operations, therefore "morphological derivations must directly reflect syntactic derivations and vice versa" (1985:375). In fact he tries to associate syntactic operations with morphological structures.

Affix ordering has been the topic of investigation in Realization OT as well. According to Aronoff and Xu (2010: 381) one important factor in determining the order of inflectional affixes in a language is "semantic scope". They follow Rice (2000:24) who has defined scope as follows:

"Scope concerns semantic compositionality. In particular, given three items X,Y, and Z, items X and Y combine with each other and then combine as a unit with Z. The semantics of Z is added to that of X and Y as a unit".

The notion of scope as a constraint was proposed first by Spencer (2003:643), and then modified by Aronoff & Xu (2010: 389) as follows:

"Given two scope-bearing features f_1 and f_2, if f_1 scopes over f_2, then l_2 an exponent of f_2 cannot be farther away from the same stem than l_1, an exponent of f_1".

Scope constraints are markedness constraints which associate semantic scope with linear order. In the rest of this section the order of inflectional elements in Persian stems are discussed by exploiting the notion of scope constraints.

In Persian inflected forms it is possible to have multiple affixation in a single stem. In case of verbs for instance, the form "xor-d-im" (we ate) has two inflectional suffixes: *-d* for past tense, and *–im* for person and number agreement. There is a fixed order for the occurrence of these two suffixes, with the tense suffix preceding the agreement one. Therefore we can propose the following scope constraint:

56. Scope (tense,agreement)

It means the tense marker must be closer to the verb stem than the agreement marker. The following tableau can show the situation for selecting the optimal candidate:

57. The order of suffixes in "xordim":

xor, tense, 1st,pl agr[1]	{tense}: -d	{agr/1st, pl}:-im	Scope(tense,agr)
☞ xor-d-im			
xor-im-d			*!

We can also see the prefix ordering in Persian verbs as well. For instance the features of negation and habitual aspect are realized by two prefixes, *ne-*[2] and *mi-*, with negative prefix *ne-* always preceding the aspect one *mi-*. Thus we can propose the following scope constraint for the situation:

58. Scope (aspect, negation)

It means that the aspect prefix scopes over the negative prefix, and will be closer to the verb stem; thus, if both of these affixes are present in the verb, the leftmost one is the negative prefix:

neg[3], asp[4], xor	{neg}: ne-	{asp}: mi-	Scope (asp,neg)
☞ ne-mi-xord			
mi-ne-xord			*!

We can use the scope constraint to determine the order of inflectional affix and clitic as well. In Persian the two features of plurality and possession can be realized in a single noun, the former by a suffix, and the latter by a clitic:

59. ketab-ha-j-□m[5]

book-pl-c-poss

(my books)

Because it is the only possible ordering of the two elements, and the plural suffix is always closer to the noun, the following scope constraints can be proposed:

60. Scope (number,possession)

The following tableau shows the optimal candidate with regard to the order of these two elements:

ketab,pl,poss	{pl}:-ha	{poss/1st, sing}: □m	ONSET	Scope (num,poss)	DEP IO
ketab-ha-□m			*!		
ketab-□m-ha				*!	
☞ ketab-ha-jam					*

As we saw, the scope constraints can account for the order of inflectional elements within the Realization OT framework.

4. Conclusion

In this article we investigated some aspects of Persian inflection in Realization OT, which is mainly developed to fulfill inflectional issues. One of the most important advantages of this new version of OT is the possibility to introduce new language-specific constraints which can enable us to predict and select the optimal

[1]."agr" stands for agreement.

[2]. If the negative prefix is the only prefix of the verb stem, another allomorph of it will be presented which is n□-.

[3]. "neg" stands for negation.

[4]. "asp" stands for aspect.

[5]. In informal (spoken) Persian the form "ketab-ha-m" is used, which is the result of vowel deletion (c.f. section 3.2).

candidates appropriately. Of course in a language like Persian with different varieties we may need to have different rankings of the constraints to select the appropriate candidates in each variety. Besides this point, the model cannot explain the situations where there is more than one optimal candidate with no grammatical or stylistic reasons either.

Another advantage of Realization OT is that it can show the interaction between morphology and phonology, and the effect of morphology on the phonology of the words. A good example was the selection of different inserted consonants to prevent the vowel hiatus, which was due to the type of the element added to the word.

Although the main goal of Realization OT is dealing with inflection and the realization of morphosyntactic properties, it may be exploited in the domain of derivation as well, and this is a topic for the future investigations.

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