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Assimilation as the Residue of AGREE

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Abstract: An Optimality Theoretic approach to assimilation is proposed where all assimilation processes result from the interaction of a single syntagmatic markedness constraint that requires sequences of sounds to AGREE in *all* feature specifications with a variety of faithfulness constraints that seek to IDENT input feature specifications. Assimilation or the lack of it is the residue of AGREE after satisfaction of higher ranked IDENT constraints. AGREE is analyzed as a single gradient constraint rather than a set of categorical constraints each obligating agreement in a specific feature. The study concludes that a gradient interpretation of AGREE is theoretically appropriate since it meets the general principle of economy in the structure of our language faculty and also supports the general move towards convergence rather than divergence in linguistic analysis. The outcomes of the study also prove to be practically appropriate in handling various assimilation processes from different languages.

Key words: agree, assimilation, gradience, optimality theory

1. Introduction

Within Optimality Theory (Prince and Smolensky 1993; McCarthy and Prince 1993), assimilation is seen as a conflict between faithfulness constraints that require identity between input and output features on the one hand (1), and syntagmatic constraints that demand sequences of output segments to agree in feature specifications (2) (Lombardi 1995, 1996, 1999; Bakovic 1999, 2000a, b, Walker 2000).

(1) IDENT [F]

Correspondent segments are identical in feature [F].

(2) AGREE [F]

A sequence of segments must have the same specifications for feature [F].

A variant approach to assimilation within Optimality Theory involves the use of Alignment constraints that require the edges of linguistic structures to coincide (Kirchner 1993; McCarthy & Prince 1993; Prince & Smolensky 1993). When alignment constraints are evaluated gradiently, they discriminate among candidates that are imperfectly aligned. Gradient alignment constraints have often been used to enforce autosegmental spreading by requiring a distinctive feature to be associated with the leftmost or rightmost segment in some domain (McCarthy 2011). More recently, McCarthy (2011) proposes the use of SHARE (F) to account for assimilation processes. The approach eliminates the undesirable typological predictions of the previous approaches. The current approach will use AGREE but the arguments presented, we believe, may be used with SHARE constraints in the same manner.

There are as many identity and agreement constraints in grammar as there are features responsible for the various types of assimilation processes. The relative ranking of these constraints accounts for assimilation or the lack of it. Ranking an identity constraint over an agreement constraint for a particular feature blocks assimilation for that feature (3). Conversely, ranking an agreement constraint higher than an identity constraint for a particular feature triggers output assimilation in that feature (4).

(3) Assimilation blocked

IDENT [Fi] >> AGREE [Fi]

(4) Assimilation triggered

AGREE [Fi] >> IDENT [Fi]

This paper aims at answering the following questions: Is it possible to reduce the family of AGREE constraints generally assumed to be responsible for phonological assimilation processes in analyses within Optimality Theory, to a single gradiently-violable constraint? Based on this interpretation of AGREE, can all typological variation be accounted for by ranking permutations of a range of Input-Output faithfulness constraints? Other than the considerable reduction in the number of constraints in the grammar, the current proposal still requires extensive research to explain possible effects on factorial typology and learnability. The discussion below basically considers cases of assimilation between adjacent consonants across a word boundary. Further investigation is required to see if the proposal in this paper is valid for other domains and other types of segments. Particularly word-internal assimilation processes and long distance harmony may require more stipulations and modifications of the current proposal.

2. A Hypothetical illustration

A hypothetical input cluster such as /np/ differs in place of articulation, voicing, and nasality, among other things. This implies that there are at least three active IDENT constraints and three active AGREE constraints introduced in (5) and (6), respectively. These constraints will need to make reference to the phonological domain where they are active. IDENT constraints may require feature identity within a root but not in an affix. AGREE constraints may also require feature agreement of sequences within a root, in a root-stem sequence, or in sequences across a word boundary.

(5) Three IDENT constraints

a. IDENT(place) ID(PL)

An input segment retains its place of articulation in its output correspondent.

b. IDENT(voice) ID(VO)

An input segment retains its specification for voice in its output correspondent.

c. IDENT(nasality) ID(NAS)

An input segment retains its nasal/oral value in its output correspondent.

(6) Three AGREE constraints

a. AGREE(place) AG(PL)
A sequence of segments must be identical in place of articulation
b. AGREE(voice) AG(VO)
A sequence of segments must be identical in voicing
c. AGREE(nasality) AG(NAS)
A sequence of segments must be identical in nasality

Possible output candidates for the input /np/ include, but are certainly not limited to, the clusters in (7)

(7) Candidate outputs for /np/

a. [np] b. [nb] c. [nn] d. [mp] e. [mb] f. [mm]

Candidate (7a) is optimal in an 'anything goes' scenario where all nasal-obstruent clusters are permitted. This occurs when all IDENT constraints outrank all AGREE constraints as shown in (8)

(8) All IDENT >> all AGREE

/np/	ID(PL)	ID(VO)	ID(NAS)	AG(PL)	AG(VO)	AG (NAS)
a.☞[np]				*	*	*
b.[nb]		*!		*		*
c.[nn]	*!		*			
d.[mp]	*!				*	*
e.[mb]	*!	*				*
f.[mm]	*!	*	*			

Candidate (8a) is optimal since all IDENT constraints outrank all AGREE constraints. In such grammars, all consonant clusters are licensed. No crucial ranking relations hold between members of IDENT or AGREE.

To render [nb] optimal and trigger voice assimilation, AGREE(VO) should rank higher than IDENT(VO) as shown in the hierarchy in (9).

(9) ID(PL), ID(NAS) >> AG(PL), AG(VO), AG (NAS) >> ID(VO)

The relative ranking of ID(VO) with AG(PL) and AG(NAS) is non-crucial - justifying placing ID(VO) lowest in the hierarchy. The implication is that all AGREE constraints are still *unranked* relative to each other.

To render [mp] optimal, AGREE(PL) ranks higher than IDENT(PL) as shown in the hierarchy in (10)

(10) ID(VO), ID(NAS) >> AG(PL), AG(VO), AG (NAS) >> ID(PL).

Again, note that the relative ranking of ID(PL) with AG(VO), AG (NAS) is *non-crucial*, and all AGREE constraints are still unranked relative to each other.

To render [mb] optimal, both AGREE(PL) and AGREE(VO) will need to be ranked higher than the corresponding IDENT constraints as shown in (11) where all AGREE constraints are still unranked relative to each other.

(11) AGREE(PL), AGREE(VO) >> all IDENT

/np/	ID(NAS)	AG(PL)	AG(VO)	AG(NAS)	ID(PL)	ID(VO)
a.[np]		*!	*	*		
b.[nb]		*!		*		*
c.[nn]	*!				*	*

d.[mp]			*!	*	*	
e.☞[mb]				*	*	*
f.[mm]	*!				*	*

The argument that all AGREE constraints are not crucially ranked still holds.
To make [mm] optimal, it is necessary to rank all AGREE constraints higher than all IDENT constraints as shown in (12)

(12) All AGREE >> all IDENT

/np/	AG(PL)	AG(VO)	AG(NAS)	ID(PL)	ID(VO)	ID(NAS)
a.[np]	*!	*	*			
b.[nb]	*!		*		*	
c.☞ [nn]				*	*	*
d.[mp]		*!	*	*		
e.[mb]			*	*	*	
f.☞ [mm]				*	*	*

Although the hierarchy does serve to make [mm] optimal, it fails to rule out [nn]. A more specific IDENT constraint that outranks all AGREE constraints would be required to rule out [nn] and chose [mm]. Prince and Smolensky (1993) introduce the notion of Harmonic Constraint Rankings between faithfulness constraints with universal rankings across languages. A constraint that requires obstruents to retain their place of articulation (13) is invariably ranked higher than a constraint requiring nasals to retain their place of articulation (14). This harmonic relation (15) is phonetically grounded since place distinctions are more perceptually salient on obstruents than on nasals (Pulleyblank 1997:68).

(13) IDENT(PL) OBSTRUENTS

Obstruents must retain their place of articulation in the output.

(14) IDENT(PL) NASALS

Nasals must retain their place of articulation in the output.

(15) Harmonic ranking

IDENT(PL) OBSTRUENTS >> IDENT(PL) NASALS

Ranking IDENT(PL) OBSTRUENTS higher than all AGREE constraints renders [mm] optimal. On the other hand, rendering [nn] optimal may require a positional faithfulness constraint which retains place of articulation for [n] or the general IDENT-I/O which is violated once by [nn] but twice by [mm].

The notion of harmonic rankings is essential for the purposes of the current discussion since it establishes a crucial ranking relation between members of IDENT while the non-ranking relation still holds between all AGREE constraints.

3. Assimilation as a residue

An investigation of selected assimilation processes from different languages leads to the conclusion that assimilation may be viewed either as the residue of IDENT or the residue of AGREE.

3.1 Assimilation as the residue of IDENT

Assimilation may be considered as the product of a single and very powerful faithfulness constraint that seeks to preserve input specifications. This constraint is outranked by a variety of markedness constraints; each obligating selected sequences of sounds to agree in a certain feature specification as shown in (16) for place assimilation. Subsequent to satisfying the higher ranked AGREE, whatever is left of IDENT is the output. Accordingly, assimilation is the residue of IDENT.

(16) Assimilation as the residue of IDENT

AGREE(PLACE) >> IDENT-IO >> all other AGREE constraints

According to (16), a simplistic input sequence like /tg/ would surface as [kg] or [td] where place agrees and all other input features are preserved in the output. The preference between the two potential candidates is the outcome of a higher ranked constraint which preserves place of articulation for dorsals, optimizing [kg] (17), or one preserving place of articulation for coronals, and hence optimizing [td] (18).

(17) IDENT(PLACE) DORSALS >> AGREE(PLACE) >> IDENT-IO

(18) IDENT(PLACE) CORONALS >> AGREE(PLACE) >> IDENT-IO

The direct observation is the fact that IDENT does not seem to be as powerful and intact as predicted. A member of the IDENT-IO constraint set, namely IDENT(PLACE) DORSALS, or IDENT(PLACE) CORONALS must leave the constraint family and rank higher than AGREE(PLACE).

3.2 Assimilation as the residue of AGREE

The alternative approach is to consider assimilation as the interaction between a single powerful markedness constraint that disallows articulatory inertia-changes in the position of articulators (Pulleyblank 1997) and a variety of faithfulness constraints; each obligating output identity to a certain input feature specification as shown in (19) for place assimilation. Whatever is left of AGREE is the output - after satisfying the higher ranked IDENT constraints. Consequently, assimilation is the residue of AGREE.

(19) Assimilation as the residue of AGREE

All IDENT constraints except IDENT(PLACE) >> AGREE >> IDENT(PLACE)

By the hierarchy in (19), a simplistic input sequence like /tg/ would surface as [kg] or [td] where place agrees and all other input features are preserved in the output due to a set of higher ranked IDENT constraints that seek to preserve input features except place of articulation. The preference between the two potential candidates depends on the ranking of members of the IDENT(PLACE) family, namely IDENT(PLACE) DORSALS, or IDENT(PLACE) CORONALS compared to AGREE. If AGREE outranks IDENT(PLACE) DORSALS, [td] is optimal (20), while if AGREE outranks IDENT(PLACE) CORONALS, [kg] is rendered optimal (21).

(20) Rendering [td] optimal from input /tg/

All IDENT constraints except IDENT(PLACE) DORSALS >> AGREE >> IDENT(PLACE) DORSALS

(21) Rendering [kg] optimal from input /tg/

All IDENT constraints except IDENT(PLACE) CORONALS >> AGREE >> IDENT(PLACE) CORONALS.

It is worth noting that the lower ranked IDENT(PLACE) DORSALS in (20) and IDENT(PLACE) CORONALS in (21) may be simply replaced by the more general IDENT-IO by virtue of constraint rankings in (20) and (21), any crucial violations of IDENT-IO will necessarily concern IDENT(PLACE) DORSALS or IDENT(PLACE) CORONALS. Candidates violating any other constraints are ruled out by IDENT constraints ranked higher than AGREE. A more thorough examination of this motivation is provided in the discussion that follows.

4. The observation

The basic observation is the fact that when accounting for assimilation processes in any language, members of AGREE are always *unranked* relative to each other. The relative ranking of the various IDENT constraints accounts for limiting the power of AGREE. AGREE behaves like a gradient constraint that evaluates candidates for all features. Each feature, not shared by the sequence of sounds within the designated domain, incurs a violation of AGREE.

All AGREE constraints make reference to phonological features in output sequences of sounds. Each of these constraints has a corresponding input-output IDENT constraint which makes reference to the same feature. IDENT constraints may, however, require base-reduplicant, stem-output, or even output-output correspondence; levels which are not targeted by any AGREE constraint. This implies that AGREE is strictly an assimilation device in grammar.

5. The proposal

We propose a cross-linguistic approach to assimilation whereby all AGREE constraints in grammar are non-ranked relative to each other. The implication is to view AGREE as a gradient constraint that seeks total assimilation between sequences of output segments. Violations of this requirement result from higher ranked IDENT constraints. Accordingly, assimilation is the residue of AGREE as noted earlier in 3.2. In line with this **proposal**, any assimilation process will have a constraint hierarchy similar to (22)

(22) General constraint hierarchy for assimilation

IDENT constraints for all features that are preserved in output segments >> AGREE >> IDENT constraints for all features that assimilate

This proposal is based on the following hypotheses:

First: No ranking conflicts between AGREE constraints.

By definition, OT aims to select a particular output form from a virtually infinite set of potential candidates produced by GEN. There will always be a candidate that satisfies all AGREE constraints in the language. That candidate is optimal despite the ranking of the various AGREE constraints. For example, the three AGREE constraints in (23) will have six possible rankings shown in (24)

(23) AGREE(PLACE), AGREE(VOICE), AGREE(NASALITY)

(24) Possible constraint rankings

a. AGREE(PLACE)>>AGREE(VOICE)>>AGREE(NASALITY)
b. AGREE(PLACE) >>AGREE(NASALITY) >>AGREE(VOICE)
c. AGREE(VOICE)>>AGREE(PLACE)>> AGREE(NASALITY)
d. AGREE(VOICE) >> AGREE(NASALITY) >>AGREE(PLACE)
e. AGREE(NASALITY)>>AGREE(PLACE)>>AGREE(VOICE)
f. AGREE(NASALITY) >>AGREE(VOICE) >>AGREE(PLACE)

For a hypothetical input sequence like /np/, all constraint rankings in (24) will select the same candidates, [nn] or [mm] as shown exemplified in (25) for the hierarchy in (24a). To limit the potential number of candidates, we are supposing that nasals must be preserved, stops remain stops, and segment deletion is ruled out by a higher ranked MAX-IO.

(25) No conflict between AGREE constraints

/np/	AGREE (PLACE)	AGREE (VOICE)	AGREE (NASALITY)
a. np	*!	*	*
b. nb	*!		*
c. nd			*!
d. ☞nn			
e. mp		*!	*
f. mb			*!
g. ☞mm			

Any ranking of AGREE constraints will always select the identical clusters as optimal. If the optimal output for /np/ is [nb], this is not a result of ranking AGREE(VOICE) over AGREE(PLACE) and AGREE(NASALITY), but rather ranking IDENT(PLACE) and IDENT(NASALITY) higher than the general requirement to AGREE.

Second: AGREE behaves like a gradient constraint.

The number of violations incurred by a sequence of sounds equals the *number* rather than the *quality* of features not shared by the sounds in question. In view of this, the sequence [td] incurs a single violation of AGREE and so does [ts] and [tp]. [td] disagrees in voice specifications while [ts] disagrees in manner, and [tp] in place of articulation. Accordingly, (25a) can be represented as in (26) with AGREE as a gradient constraint.

(26) AGREE as a gradient constraint

/np/	AGREE
a. np	*!**
b. nb	*!*
c. nd	*!
d. ☞nn	
e. mp	*!*
f. mb	*!
g. ☞mm	

Third: Equal number of AGREE and IDENT

Theoretically, the number of IDENT constraints *active* in assimilation processes equals the number of AGREE constraints. Each higher ranked IDENT constraint neutralizes the corresponding AGREE constraint to block assimilation in the feature in question. The AGREE constraints that are not neutralized surface in the form of assimilation as formalized in (27).

(27) Assimilation as the residue of AGREE

IDENT(F1), IDENT(F2), IDENT(F3),… IDENT(Fn-1) >>

AGREE(F1), AGREE(F2), AGREE(F3),… AGREE(Fn-1), AGREE(Fn) >> IDENT (Fn)

neutralized neutralized neutralized neutralized

assimilation in (Fn)

Fourth: The optimal candidate is either selected by AGREE or IDENT

Deciding on the optimal candidate is the function of AGREE when two potential candidates equally satisfy, or violate, all higher ranked IDENT constraints and one of them incurs less violations of AGREE. Deciding on the optimal candidate may also be a function of higher ranked IDENT constraints when the demands to retain input feature specifications yield the optimal candidate even before AGREE is given the chance to evaluate the sequence. Lower ranked IDENT constraints may also optimize a candidate when two candidates equally satisfy or violate the higher ranked IDENT constraints and incur an equal number of violations of AGREE. Examples will be discussed in section (6).

6. Applications

In Bura, a Chadiac language of Nigeria, discussed within OT by Pulleyblank (1997), all nasal-obstruent clusters are allowed as shown in (28)

(28) Bura: nasal-obstruent clusters

Cluster	Word	Gloss
[mp]	mpa	'fight'
[mb]	mba	'burn'
[mt]	mta	'death'
[md]	mda	'person'
[ms]	məska	'maternal uncle'
[mʃ]	mʃi	'corpse'
[mʒ]	mʒa	'be enough'

Bura represents a case where any nasal-obstruent clusters are allowed. This is a direct outcome of ranking all IDENT(NASAL), IDENT(CONTINUANCE), IDENT(VOICE), and IDENT(PLACE) constraints higher than all corresponding AGREE constraints relevant to the nasal-obstruent cluster as seen in (29)

(29) Nasal-Obstruent clusters in Bura

/mʃi/	IDENT				AGREE			
	NAS	CONT.	VOI	PL	NAS	CONT	VOI	PL
a. ☞ mʃi					*	*	*	*
b. nʃi				*!	*	*	*	
c. mʒi			*!		*	*		*
d. mʧi		*!			*		*	*
e. nni	*!	*	*	*				

Although candidate (29a) violates all AGREE constraints, it surfaces as the optimal candidate since it is identical to the input. Optimization is the outcome of higher ranked IDENT constraints. The ranking of AGREE constraints is not crucial as long as they are dominated by all IDENT constraints.

In Yoruba, a Niger-Congo language of Nigeria discussed by Pulleyblank (1995, 1997), a nasal prefix indicating progressive shares the place of articulation of a following obstruent as shown in (30). Vowel nasalization and tone is not marked in the transcription since they are irrelevant to the discussion.

(30) Yoruba: nasal-obstruent clusters

Place of articulation	Verb root	Progressive form	Gloss
Labial	ba	m+ ba	'overtaking'
Labiodental	fɔ	ɱ+ fɔ	'breaking
Alveolar	ta	n+ ta	'selling'
Alveolar	du	n+ du	'paining'
Alveolar	su	n+ su	'sleeping'
Alveopalatal	ɟo	ɲ+ ɟo	'dancing'
Velar	kɔ	ŋ+ kɔ	'writing'
Velar	gu	ŋ+ gu	'climbing'
Labial-velar	kpa	ŋm+ kpa	'killing'
Labial-velar	gbɔ	ŋm+ gbɔ	'hearing'

The data in (30) is readily accounted for by positing a ranking relation where AGREE(PL) is ranked higher IDENT(PL). Place of articulation for the obstruent is preserved while place of articulation for the nasal is lost due to the harmonic ranking of IDENT(PL) OBSTRUENTS over IDENT(PL) NASALS introduced earlier in (15). Accordingly, the hierarchy responsible for place assimilation in Yoruba is shown in

(31)

(31) AGREE(PL), IDENT(PL) OBSTRUENTS >> IDENT(PL) NASALS

Introduction of a partial hierarchy like (31) to account for a particular assimilation process is rather straightforward. The assimilation process is a result of conflict between two basic constraints.

Such sub-hierarchies, however, miss the overall generalization concerning the relative ranking of other IDENT and AGREE constraints in the language. More complex assimilation processes will require the ranking of a variety of relevant AGREE and IDENT constraints.

In Zoque, a Mixe-Zoquean language of southern Mexico, discussed within OT by Pulleyblank (1997), a nasal-obstruent cluster must agree in place of articulation and voicing as shown in (32)

(32) Zoque: place and voice assimilation in affix-stem sequences

Input	Output	Gloss
n+ pama	mbama	'my clothing'
n+ tatah	ndatah	'my father'
n+ ʧoʔnogoya	ɳʤoʔnogoya	'my rabbit'
n+ kayu	ŋgayu	'my horse'

The two AGREE constraints, AGREE(PL) and AGREE(VO) generate agreement in place of articulation and voicing, respectively. And they are ranked higher than the corresponding IDENT constraints, i.e., IDENT (PL) and IDENT(VO) respectively. The place of articulation is preserved in the stem rather than the affix as a result of a higher ranked constraint that preserves place of articulation in stems (33)

(33) IDENT (PL) STEM: Place of articulation for stem segments is preserved in their output correspondents.

The hierarchy responsible for place and voice assimilation in Zoque is shown in (34) and exemplified for input /n+pama/ in (35)

(34) IDENT (PL) STEM >> AGREE(PL), AGREE(VO) >> IDENT (PL), IDENT(VO)

(35) Place and voice assimilation in Zoque

n+pama	IDENT(PL) STEM	AGREE (PL)	AGREE (VO)	IDENT (PL)	IDENT (VO)
a. npama		*!	*		
b. mpama			*!	*	
c. nbama		*!			*
d.☞ mbama				*	*
e. ntama	*!		*	*	
f. ndama	*!			*	*

The nasal-obstruent cluster in (35d) exhibit agreement in place of articulation and voicing while at the same time retaining place of articulation for the stem obstruent. Candidates (35e,f) are ruled out because of fatal violations of higher ranked IDENT(PL) STEM, (35a,c) violate higher ranked AGREE(PL), and (35b) violates higher ranked AGREE(VO). Optimization is the result of satisfaction of AGREE since (35a-d) equally satisfy the higher ranked IDENT(PL) STEM. Candidates (35a-c) violate one or both AGREE constraints while (35d) satisfies them both. Note again that AGREE constraints are not-crucially ranked against each other while IDENT constraints are.

We aim to avoid use of various AGREE constraints and replace them with a blanket constraint that includes them all; thus turning AGREE into a gradient constraint. To distinguish individual AGREE constraints from their blanket parent, we will be using italicized *AGREE* to refer to the gradient understanding of AGREE adopted in this paper.

In (35), the optimal sequence [mb] incurs two violations of *AGREE* for disagreement in nasality and sonorancy. All other potential candidates disagree in at least three features as shown in (36)

(36) Place and voice assimilation in Zoque with gradient *AGREE*

n+pama	IDENT(PL) STEM	*AGREE*	IDENT (PL)	IDENT(VO)
a. npama		***!*		
b. mpama		***!		*
c. nbama		***!	*	
d.☞ mbama		**	*	*
e. ntama	*!	***		*
f. ndama	*!	**	*	*

6.1 Jordanian Arabic (JA)

In the rest of this discussion, we will elaborate on the use of *AGREE* through a discussion of the assimilatory behavior of coronal sonorants in Arabic, i.e., /n, l, r/.

6.1.1 Assimilation in Arabic

The phenomenon of assimilation as a phonological process has received considerable cross linguistic investigation (Jun, 1995; Lombardi, 1995, 1999; Hansson, 2001; Rose and Walker, 2004 among many others). In one view, assimilation is seen as deriving from the assumption that there is a *look-ahead mechanism* which causes all segments unspecified for a particular feature to have that feature spread from some later (or earlier) segment (Pavlik, 2009). This procedure has been termed feature spreading and it is considered to be a phonological phenomenon (Henke 1966; Daniloff and Hammarberg 1973; Benguerel and Cowan 1974; Goldsmith 1976; Hammarberg 1976, 1982; Nolan 1982, Clements 1985; Hayes, 1996; Pavlik, 2009). Later developments in phonology within Optimality Theory (Prince and Smolensky, 1993; McCarthy and Prince, 1993) viewed assimilation as a conflict between markedness constraints requiring sounds to share features (AGREE, SHARE) and faithfulness constraints requiring input segments to retain their feature values (IDENT) (McCarthy & Prince, 1995, Beckman, 1998; Lombardi, 1999; Baković, 2000). Assimilation processes in various Arabic dialects received attention as well (Kabra, 2011; Elramli**,** 2012; Benyoucef and Mahadin, 2013; Heselwood & Watson, 2013; Youssef, 2013). JA was no exception with a fair share of research (Zuraiq and Zhang 2006; Zuraiq and Abu-Abbas 2009; Abu-Abbas, Zuraiq and Al-Tamimi 2010; Abu-Abbas, Zuraiq, and Abdel-Ghafer, 2014; Al-Deaibes, 2016; Huneety and Mashagba, 2016; Huneety et. Al., 2021; Alshdaifat and Khashashneh, 2023).

6.1.2 Data collection

Data used in this study is part of an ongoing attempt by the researcher in collaboration with other researchers (data collectors) to document assimilation patterns in various dialects in Jordan (Zuraiq and Zhang 2006; Abu-Abbas, Zuraiq and Al-Tamimi 2010; Zuraiq and Abu-Abbas 2009). In the current study, stimuli included high frequency words in JA read in isolation randomly by three native speakers of the dialect and recorded. All words then are put in commonly-used phrases and are produced by three native speakers of the dialect and recorded. The two steps are needed to compare the final consonant in the words located in the first part of the phrase in isolation with the same final consonant in the words after being read in a phrase since assimilation is regressive. Since JA has 27 consonants (Zuraiq and Zhang 2006, Zuraiq and Abu-Abbas 2009) and glides do not occur in word-final position, the total number of phrases recorded was (27-2) (27-1) = 650 phrases. All C1C2 clusters are intervocalic. Participants are asked to read the list of phrases at a normal speaking rate and are asked to repeat the phrase three times. Participants were not told about the aim of the study to guarantee neutral productions. All speakers were recorded in a quiet chamber using Solid State Recorder (Marantz 760). The recordings were digitized (sampling rate of 22 kHz) and analyzed using PRAAT. Good quality of recordings is initially needed to ensure good stimuli for the listening task. Deciding on the cases of assimilation inside phrases was attained through listening carefully to recordings by the data collectors who are trained native speakers of the dialect. Ideally, transcription of data and the listening judgments should be the task of neutral native speakers trained in phonetics. The lack of such trained phoneticians in the dialect caused data collectors to rely on their own judgments. Only when all data collectors agreed that there was assimilation in 6 or more - out of 9 tokens (3 speakers multiplied by 3 tokens) - assimilation was considered to be present. Then, random samples of assimilated and non-assimilated consonants were examined acoustically to validate the listening task. This included segment relevant acoustic features like changes in duration and spectral peaks for C1 in right edge of the isolated words and in C1C2 combination. The decisions based on listening did match the displayed acoustic information of the random samples of assimilated and non-assimilated consonants.

Data in (37-38) provides examples from JA showing the basic assimilatory behavior of nasal/obstruent sequences and the /n, l, r/ possible sequences respectively. Most data used in this study is taken from Zuraiq and Abu-Abbas (2009) and Abu-Abbas, Zuraiq and Al-Tamimi (2011).

(37) Nasal-obstruent clusters

Phonemic representation	Phonetic representation	Gloss
a. /laban baarid/	[labam baarid]	'cold yoghurt'
b. /de:n majjit/	[de:m majjit]	'a dead loan'
c. /laban faater/	[labaɱ faater]	'lukewarm yogurt'
d. /ʔibin θani/	[ʔibin̪ θani]	'a second son'
e. /laban kaθiir/	[labaŋ kaθiir]	'a lot of yogurt'
f. /ʤibin gaasi/	[ʤibiŋ gaasi]	'hard cheese'
g. /de:n xasraan/	[de:ŋ xasraan]	'a misplaced loan'
h. /walad masˤri/	[walad masˤri]	'an Egyptian boy'
i. /fariig tamaam/	[fariig tamaam]	'a perfect team'

(38) /n, l, r/ sequences

a. /laban lubnaani/	[labal lubnaani]	'Lebanese yoghurt'
b. /laban ruusi/	[labar ruusi]	'Russian yoghurt'
c. /ʤidaal naafiʕ/	[ʤidaal naafiʕ]	'a useful debate'
d. /ħisˤaar naafiʕ /	[ħisˤaar naafiʕ]	'a useful siege'
e. /ʤidaal ruusi/	[ʤidaar ruusi]	'a Russian debate'
f. /mudiir lubnaani/	[mudiir lubnaani]	'a Lebanese boss'

Data in (37-38) shows that assimilation across a word boundary in JA is regressive. This is the outcome of a high ranked constraint demanding reservations of the feature specifications of onset segments (39).

(39) IDENT-ON(SET)

Onset segments retain their feature specifications in the output.

Data in (37a-g) shows that in nasal-obstruent clusters, the nasal acquires place of articulation from the following obstruent while in obstruent-nasal (37h) and obstruent-obstruent clusters (37i), assimilation is blocked. This is traditionally accounted for by the hierarchy in (40), adapted from Pulleyblank (1997:69).

(40) AGREE(PL), IDENT(PL) OBS(TRUENTS) >> IDENT(PL) NAS(ALS)

The harmonic ranking of IDENT(PL)OBS over IDENT(PL)NASALS guarantees that only nasals will assimilate in place of articulation with a following consonant. For assimilation to take place, AGREE(PL) must be ranked higher than IDENT(PL)NASALS as shown in (41) for (37a) where no domination is established between AGREE(PL) and IDENT(PL) OBS.

(40) Nasal-bilabial clusters

laban baarid	AGREE(PL)	IDENT(PL) OBS	IDENT(PL) NASALS
a. laban baarid	*!		
b. ☞ labam baarid			*
c. ☞labab baarid			*

Ruling out (40c) is a product of a faithfulness constraint demanding preservation of nasality, i.e., IDENT(NASAL). Given the argument thus far, the ranking of this constraint is quite vague. It may be ranked equally with AGREE(PL) and IDENT(PL) OBS (41), or equally with IDENT(PL) NASALS (42).

(41) AGREE(PL), IDENT(PL) OBS, IDENT(NASAL) >> IDENT(PL) NASALS

(42) AGREE(PL), IDENT(PL) OBS >> IDENT(NASAL), IDENT(PL) NASALS

No assimilation takes place in obstruent-obstruent clusters as shown in (37i) although the constraint interaction in (44) predicts otherwise.

(44) Obstruent-obstruent clusters

fariig tamaam	AGREE(PL)	IDENT(PL) OBS	IDENT(PL) NASALS
a. fariig tamaam	*!		
b. fariik tamaam	*!		
c. ☞fariit tamaam		*	
d. fariiŋ tamaam	*!		

This argument is getting more intricate; demanding the introduction of new constraints and constraint hierarchies. To rule out (44c), IDENT(PL)OBS must be ranked higher than AGREE(PL) and to rule out (44d), it would be necessary to redefine IDENT- (NASAL) so that it requires preservation of the oral/nasal specifications of an input segment, i.e., IDENT-(NAS) and rank this constraint higher than AGREE(PL). Finally, to rule out (44b), a constraint demanding preservation of laryngeal features, i.e., IDENT(VO(ICE) must be ranked higher than AGREE(PL). The final hierarchy is shown in (45) and exemplified for (37a) and (37i) in (46) and (47) respectively.

(45) IDENT(PL)OBS, IDENT(NAS), IDENT (VO) >> AGREE(PL) >> IDENT(PL) NASALS

(46) AGREE(PL) as optimizer

laban baarid	IDENT (PL)OBS	IDENT(NAS)	IDENT(VO)	AGREE(PL)	IDENT(PL) NASALS
a. laban baarid				*!	
b.☞ labam baarid					*
c. labab baarid		*!			

Candidate (46b) is optimal since the nasal-obstruent sequence agrees in place of articulation while in (46a). The cluster has different values for place. AGREE(PL) is the optimizer.

(47) IDENT(VO) as optimizer

fariig tamaam	IDENT (PL)OBS	IDENT(NAS)	IDENT(VO)	AGREE(PL)	IDENT(PL) NASALS
a.☞fariig tamaam				*	
b. fariik tamaam			*!	*	
c. fariit tamaam	*!		*		
d. fariiŋ tamaam		*!		*	

Candidate (47) is optimized because all other potential candidate violate an IDENT constraint ranked higher than AGREE(PL). Thus, optimization is the function of higher ranked IDENT.

Of interest at this moment is the observation that replacing AGREE(PL) in (46) and (47) with the more powerful gradient *AGREE* constraint adopted in this paper yields the same optimal candidates. In (47), AGREE(PL) is not an optimizer as indicated by the shading. Tableau (46) is repeated in (48) replacing AGREE(PL) with *AGREE*

(48) Gradient *AGREE* yielding same results

laban baarid	IDENT (PL)OBS	IDENT(NAS)	IDENT(VO)	*AGREE*	IDENT(PL) NASALS
a. laban baarid				***!	
b.☞ labam baarid				**	*
c. labab baarid		*!			

Regardless of the number of violations of *AGREE* incurred by the optimal (48b), candidate (48a) incurs the same violations plus one for disagreement in place of articulation. In (48), the cluster /mb/ disagrees in nasality and sonorancy while /nb/ disagrees in nasality, sonorancy, and place of articulation.

Data in (38) exemplifies the assimilatory behavior of the two liquids in JA. The coronal nasal assimilates to a following liquid (38a, b) but not vice versa (38c, d), and the lateral liquid assimilates to a following retroflex liquid (38 e) but not vice versa (38 f).

The fact that the nasal /n/ looses nasality when followed by a liquid challenges IDENT(NAS) and poses a ranking problem. It was established in (48) that IDENT(NAS) muse be ranked higher than *AGREE* to optimize the correct candidate while to account for (38a,b), it is essential to rank *AGREE* higher than

IDENT(NAS). To solve the apparent paradox, we introduce a constraint that seeks preservation of the sonority value of an input segment. This constraint is introduced in (49)

(49) PRESERVE(SON(ORANCY)

The sonority value of an input segment must be preserved in the output

This constraint is violated when an output segment is less sonorous than its input correspondent, i.e., an increase in sonority is tolerated while a decrease is penalized. The fact that liquids are more sonorous than nasals justifies assimilation in (38a, b) as shown in (50) for (38a) and the lack of assimilation in (38c, d) as shown in (51) for (38c).

(50) Nasal-liquid clusters

laban lubnaani	PRESERVE (SON)	*AGREE*
a. laban lubnaani		*!*
b.☞ labal lubnaani		
c. labar lubnaani		*!*
d. labad lubnaani	*!	**

The optimal candidate satisfies both constraints. Candidate (50a) incurs two violations of *AGREE* for disagreement in oral/nasal and the central/lateral features. Candidate (50c) also incurs two violations of *AGREE* but for central/lateral and retroflexion disagreement. Candidate (50d) is ruled out by the demands of the higher ranked PRESERVE (SON).

(51) Liquid-nasal clusters

ʤidaal naafiʕ	PRESERVE (SON)	*AGREE*
a. ☞ʤidaal naafiʕ		**
b. ʤidaan naafiʕ	*!	
c. ☞ʤidaar naafiʕ		**
d. ʤidaad naafiʕ	*!	**

Based on the hierarchy introduced so far, both (51a) and (51c) are equally optimal. Both candidates incur two violations of *AGREE* although for different features. While the sequence /ln/ disagrees in oral/nasal and lateral/central features, the sequence /rn/ disagrees in oral/nasal and retroflexion.

Determining the optimal candidate in this case is the function of a constraint ranked lower than *AGREE*. We propose that this is the IDENT constraint that requires *full* identity between the input and output, i.e., IDENT-IO. Practically, this constraint is made up of a set of IDENT constraints that make reference to features not expressed by the IDENT constraints ranked higher than *AGREE* as schematized in (52) for a hypothetical set of five features.

(52) IDENT(F1), IDENT(F2), IDENT(F3) >> *AGREE* >> IDENT(F4), IDENT(F5)

Practically, IDENT(F4), IDENT(F5) can be replaced by the more general IDENT-IO which requires complete faithfulness to input specifications. The rationale is the fact that the lower ranked IDENT constraints will never be optimizers unless the competing candidates already satisfy all higher ranked IDENT constraints. Candidates (51a, c) are both faithful to the higher ranked PRESERVE (SON) and to all other IDENT constraints ranked higher than *AGREE*. The lower ranked IDENT-IO will optimize (51a) since the sequence is identical to the input. In such cases a single violation mark is assigned if the segment is not faithful to the input.

Introducing PRESERVE (SON) also explains the assimilation of the lateral to a following trill since the latter is higher in sonority as shown in (53) for (38e), while assimilation is blocked in (38f) since the lateral is less sonorous than the preceding trill as shown in (54) for (38f). Replacing IDENT(NAS) with PRESERVE (SON(ORANCY) still properly optimizes the correct candidate in (48) as shown in (55).

(53) Lateral-trill clusters

ʤidaal ruusi	PRESERVE (SON)	*AGREE*	IDENT-IO
a. ☞ ʤidaar ruusi			*
b. ʤidaal ruusi		*!	
c. ʤidaan ruusi	*!	**	*
d. ʤidaad ruusi	*!	**	*

(54) Trill-lateral clusters

mudiir lubnaani	PRESERVE (SON)	*AGREE*	IDENT-IO
a. ☞ mudiir laʔiim		*	
b. mudiil laʔiim	*!		*
c. mudiin laʔiim	*!	**	*
d. mudiid laʔiim	*!	**	*

(55) Nasal-bilabial clusters

laban baarid	IDENT (PL)OBS	PRESERVE (SON)	IDENT(VO)	*AGREE*	IDENT-IO
a. laban baarid				***!	
b.☞ labam baarid				**	*
c. labab baarid		*!			*

7. Conclusions

This paper aimed basically at introducing a single syntagmatic AGREE constraint that demands sequences of sounds to agree in all feature specifications. AGREE is treated as gradient constraint which assigns a violation mark for every feature not shared by a sequence of sounds within a specific domain. This constraint interacts with a variety of faithfulness constraints demanding feature identity between the input and output to account for all assimilation processes.

The proposal hinges on the assumption that there are no ranking conflicts between individual AGREE constraints and the number of violations incurred by a sequence of sounds equals the *number* rather than the *quality* of features not shared by the sounds in question.

Evidence from a variety of languages is provided in support of the claims made in the paper. A better understanding of the applications and implications of the proposal may be attained through a comprehensive account of various assimilation processes within a particular language. Most research on assimilation is limited to a single assimilation process such as place or voice assimilation. We believe that a more satisfactory understanding of *AGREE* as outlined in this paper requires investigation of a variety of assimilation processes with a particular language in order to determine the validity of the proposal. A pervasive AGREE constraint capable of accounting for a variety of assimilation processes in the majority of languages is a rather promising approach that we believe worth pursuing.

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