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Non-contiguous metathesis in Spoken Iraqi Arabic: An optimality-theoretic study

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Abstract: This study investigates the phonological process of non-contiguous metathesis in spoken Iraqi Arabic (henceforth SIA) within the framework of Optimality Theory (henceforth OT). The study aims to test OT's capability to account for non-contiguous metathesis in SIA and to identify the triggers behind this phonological process. Following the presentation of SIA data, an OT analysis is developed. The results demonstrate that OT effectively describes and explains all instances of non-contiguous metathesis identified in the study. Regarding the triggers for this process, the analysis identifies four distinct patterns of non-contiguous metathesis in SIA, each driven by specific constraints: the first pattern is triggered by sonority-related constraints, the second by feature agreement constraints, the third by sequential constraints, and the fourth by alignment constraints. These findings indicate that, in SIA, resolving marked structures of the language takes precedence over preserving the linear order of segments.

Keywords: *Metathesis, Non-contiguous metathesis, Optimality theory, Phonological processes, Phonology, Spoken Iraqi Arabic.*

1. Introduction

Metathesis, the process by which the linear order of segments is rearranged, is a phonological process found in many languages around the world. Despite its widespread occurrence, it is still considered a poorly understood process. While metathesis has been observed in a wide range of languages, it has received relatively little attention in phonological literature compared to other well-studied processes such as assimilation, deletion, and epenthesis [1].

In some Arabic dialects, particularly in SIA, metathesis remains full of mystery to phonological theorizing. Therefore, this study provides an OT account [2, 3] of metathesis in SIA.

This study is limited to one type of metathesis, namely non-contiguous metathesis, and aims to address the following questions:

1. Can OT account for non-contiguous metathesis in SIA?
2. What triggers non-contiguous metathesis in SIA?

This study is structured as follows: Section 2 presents an overview of OT. Section 3 provides an overview of metathesis. Section 4 discusses spoken Iraqi Arabic. Section 5 reviews previous studies on metathesis. Section 6 outlines the procedures of the study. Section 7 offers an OT analysis of non-contiguous metathesis in SIA. Finally, Section 8 summarizes the main conclusions of the study.

2. OT

OT is a relatively recent grammatical framework introduced by Prince and Smolensky [2] developed from Generative Phonology. However, it represents a significant departure from Generative Phonology and other rule-based theories like auto segmental and linear phonology. In OT, traditional rules are abandoned, and the explanatory focus is placed entirely on the constraints of Universal

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Grammar. The core concept of OT is that the surface forms of language result from resolving conflicts between competing constraints. A surface form is deemed optimal if it incurs the fewest significant violations among a set of violable constraints ranked in a hierarchy unique to each language.

2.1. OT: Principles

The mechanism of OT is built on several key principles, which are outlined below according to Prince and Smolensky [2]; McCarthy and Prince [4]; McCarthy and Prince [5]; McCarthy and Prince [6] and Kager [7].

- Universality: Constraints exist universally across all languages.
- Ranking: Each language has a unique hierarchy of constraints that shapes its grammar.
- Violability: Constraints can be minimally violated to fulfill higher-ranked ones.
- Optimality: The optimal output is the candidate with the least severe violations.
- Domination: Conflicting constraints are resolved by prioritizing the higher-ranked one.
- Fallacy of Perfection: No candidate satisfies all constraints perfectly; the goal is the most harmonious output..
- Inclusiveness: Only inclusive and conceivable candidates are generated to ensure a well-formed output..
- Parallelism: Candidates are generated in parallel.

2.2. OT: Framework

The mechanism of OT is defined simply as a relationship between input and output, where each input has a specific output [8]. OT grammar consists of four main components: LEX, GEN, EVAL, and CON [9, 10].

1. LEX (Lexicon)**:** The lexicon stores underlying forms, which serve as inputs to GEN. According to the Richness of the Base hypothesis [2, 11] no constraints apply at this level, meaning the lexicon is unrestricted and universal [7, 10].
2. GEN (Generator)**:** GEN generates a candidate set of possible output forms from an input, creating a range of alternatives, most of which are ungrammatical. Only one candidate, the optimal form, is selected through evaluation [8, 12].
3. EVAL (Evaluator)**:** EVAL selects the optimal candidate from the candidate set by applying a language-specific hierarchy of constraints from CON. It evaluates each candidate to determine the best output [8].
4. CON (Constraints)**:** CON is the core of the phonological framework in OT, providing structural requirements that outputs may satisfy or violate. Constraints guide EVAL in assessing candidates to select the optimal form [7]. Constraints are divided into two main categories: markedness constraints (or structural constraints) and faithfulness constraints [13]. Markedness constraints, assess the well-formedness of output forms (surface structure) based solely on preferred structural configurations, disregarding the input forms. Faithfulness constraints, however, evaluate the resemblance between input and output forms, ensuring that the output remains faithful to the input. McCarthy [14] describes these constraints as conservative, as they resist changes to the input structure.

2.3. OT: Tables

McCarthy [8] demonstrates that the evaluation process in OT is typically illustrated using a *tables*. An example of an OT table is provided below:

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Table 1.
Con1 » Con2 » Con3» Con4.

/Input/	Con1	Con2	Con 3	Con 4
Cand-a	*!			
Cand-b		*!		
☞ Cand-c			*	*
Cand-d			**!	

In the above given table, the input form is displayed at the top left, with possible output candidates listed below. Constraints are ranked in descending order from left to right, represented as Con1 » Con2 » Con3 » Con4, where » indicates that each constraint outranks the one following it. A solid line between columns shows strict ranking, while a dotted line signifies equal ranking. Blank cells mean the constraint is met, while shaded cells mark irrelevant violations, as the candidate was eliminated due to a fatal violation in a higher-ranked constraint. Once a winner is determined, its cells are shaded, as seen with candidate (c) under Constraint 4. McCarthy [8] explains that an asterisk (*) shows a violation, and (*!) denotes a fatal violation, which leads to elimination if a high-ranked constraint isn't met. In this table, candidate (a) is eliminated due to a fatal violation of Constraint 1, which candidates (b), (c), and (d) meet better. Candidate (b) is then eliminated for fatally violating Constraint 2, which (c) and (d) satisfy. The choice proceeds to Constraint 3, where candidate (c) is optimal due to fewer violations than (d). The optimal candidate is marked with a pointing finger (☞).

3. Metathesis

Metathesis is a process where two segments in a specific sequence within a word appear in the reverse sequence in another form of that word. These segments may involve two consonants, a consonant and a vowel, or two vowels. From the perspective of language change, one order is seen as the original (input), while the other is the result of metathesis (output) [1].

Hume [15] defines metathesis as "the process whereby in certain languages, under certain conditions, sounds appear to switch positions with one another. Thus, in a string of sounds where we would expect the linear ordering of two sounds to be ...xy..., we find instead ...yx...." (p. 1).

Based on the distance between metathesized segments, metathesis can be grouped into two types: *Contiguous metathesis*, also known as adjacent or local metathesis, occurs when the segments undergoing metathesis are in direct contact without any intervening segments between them. *Non-contiguous metathesis*, also known as non-adjacent or long-distance metathesis, occurs when the segments undergoing metathesis are separated by one or more intervening segments [16].

4. Spoken Iraqi Arabic

Iraqi Arabic, often referred to as Mesopotamian Arabic, is the most commonly spoken dialect in Iraq, with nearly eighty percent of the population using it as their native language [17, 18].

SIA, like other dialects, has its own distinct phonetic and phonological systems, which include a specific set of consonants and vowels. The phonology of SIA consists of 40 phonemes: 8 monophthongal vowels, including 3 short vowels /i, u, a/ and 5 long vowels /iː, eː, aː, oː, uː/, as well as 32 consonants. The consonants in SIA are /p, b, t, ʈ, d, ɖ, k, g, q, ʔ, f, θ, ð, ð̣, s, ṣ, z, ʃ, x, ġ, ḥ, ʕ, h, tʃ, ʤ, m, n, l, ɭ, r, w, y/ (as cited in Abdul Sattar [19].

In terms of syllable structure, SIA exhibits ten syllabic patterns, including open, closed, and double-closed syllables: /cv, cvv, ccvv, cvc, ccvc, cvcc, cvvc, cvvcc, ccvvc, ccvcc/. Along with this, there is an eleventh syllable pattern in SIA, which is /ccv/ [19]. The maximum number of consonants permitted in both the onset and coda positions in SIA is two, as illustrated by the formula $C_{0\text{-}2}$ V $C_{0\text{-}2}$ [19].

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5. Previous Studies

Along its literature, OT has been applied to investigate metathesis in various Arabic dialects, such as Algerian Arabic (see Benyoucef and Mahadin [20]), Najdi Arabic (see Alqahtani [21]), Libyan Arabic (see Elramli [22]), Syrian Arabic (see Habib [23]), and Moroccan Arabic (see Idrissi [24]). However, no study has yet attempted to account for this process in SIA using OT's theoretical framework. Metathesis in SIA has only been investigated synchronically by Jasim and Sharhan [25]. In their study, they found that metathesis involves changes in both adjacent and non-adjacent consonant sounds, and that this process does not serve any grammatical function. Therefore, they concluded that metathesis in SIA is an abrupt and sporadic process rather than gradual and systematic.

6. Procedures of the Study

The study is conducted according to the following procedures:

1. Gathering linguistic data from personal observations, documented sources, and existing studies. Ensuring that the collected words are not speech errors or slips of the tongue; instead, they are highly frequent words widely used by many Iraqi speakers.
2. Transcribing the collected words, syllabifying them, and assigning stress patterns.
3. Applying the OT framework to the collected data by first identifying relevant markedness and faithfulness constraints, proposing a ranking of these constraints, and then applying the proposed constraint rankings to analyze the data using tableaux.
4. Interpreting the findings within the framework of OT and addressing the questions of the study based on the analysis of the data.
5. Drawing conclusions based on the analysis and providing suggestions for future research.

7. Data Analysis

Non-contiguous metathesis occurs when the sounds undergoing metathesis are separated by one or more intervening sounds. In SIA, non-contiguous metathesis is more prevalent than contiguous metathesis. In this section, four distinct patterns of non-contiguous metathesis found in SIA are introduced and analyzed. Each pattern will be presented with examples in a table, followed by a detailed analysis. The instances of the first pattern of non-contiguous metathesis are provided in the following table:

Table 2.
The First Pattern of Non-contiguous Metathesis Found in SIA.

No.	Original Form	Transcription	Metathesized Form	Transcription	Metathesized Sounds	Gloss
1	غصن	/ġi.'**ṣi**n/	غنص	/ġi.'**ni**ṣ/	/ṣ/ & /n/	Bough
2	يتنصت	/jit.'**n**a**ṣ**.**ṣ**at/	يتصنت	/jit.'**ṣ**a**n**.**n**at/	/ṣ/ & /n/	He eavesdrops
3	يأس	/**j**a.'**ʔ**as/	أيس	/'**ʔaj**.**j**as/	/j/ & /ʔ/	He lost hope

In these cases, metathesis occurs to ensure that the less marked, more sonorous consonants occupy the intervocalic positions, following the markedness hierarchy for intervocalic consonants (*V_V/LAR » *V_V/OBS » *V_V/NAS » *V_V/LIQ » *V_V/GLI). According to this hierarchy, as introduced by Uffmann [26] "in intervocalic contexts, the most sonorous segments possible are preferred to minimize prominence contrast." This set of constraints prioritizes placing more sonorous consonants in intervocalic positions, minimizing the sonority contrast with surrounding vowels. Based on Selkirk [27] the sonority levels of segments are represented in the following figure:

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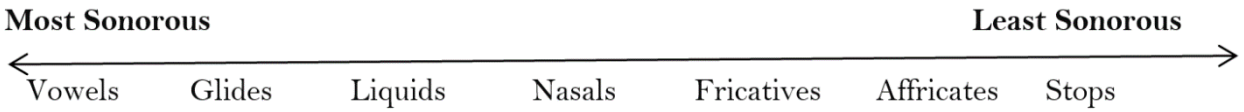

Figure 1.
Sonority Hierarchy.

In the input /ġi.'ṣin/, the obstruent /ṣ/ appears between the short vowels /i/ and /i/, which violates this constraint. Through metathesis, the output [ˌġi.'niṣˌ] positions the nasal /n/ which is more sonorous than the obstruent /ṣ/, in the intervocalic position, thus satisfying this markedness constraint. The figures below illustrate the sonority contrast with surrounding vowels before metathesis and its minimization after metathesis.

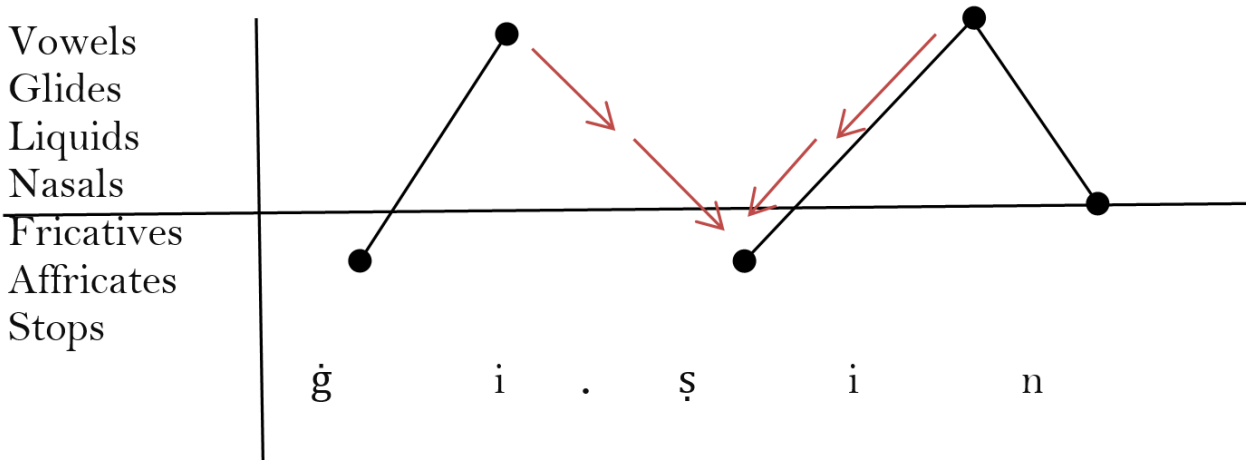

Figure 2.
The Sonority Representation of the Input /ġi.'ṣin/

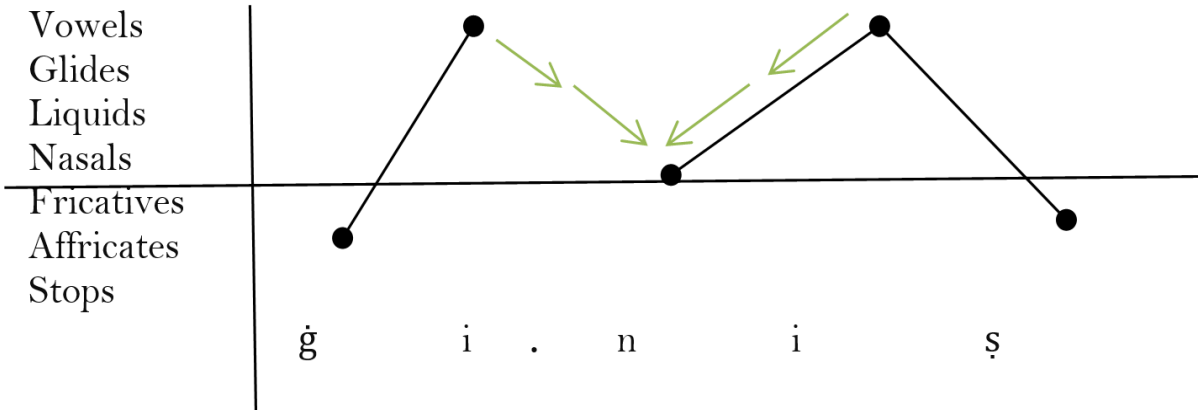

Figure 3.
The Sonority Representation of the Output [ˌġi.'niṣˌ]

Similarly, in the input /'jit.naṣ.ṣat/, the geminate obstruent /ṣṣ/ occurs between the short vowels /a/ and /a/, also violating this constraint. By switching the positions of /n/ and /ṣ/, metathesis produces [ˌ'jit.ṣan.natˌ], where the geminate nasal /nn/, now occupies the intervocalic position. The

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figures below illustrate the sonority contrast with surrounding vowels before metathesis and its minimization after metathesis.

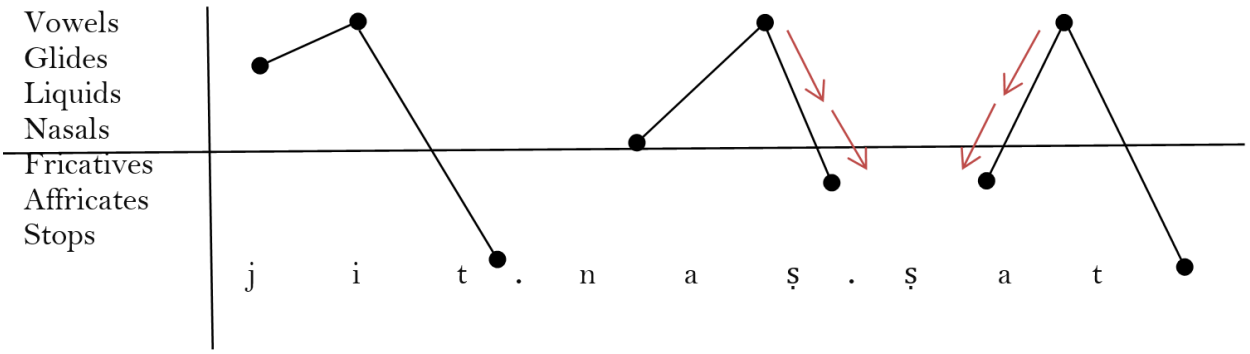

Figure 4.
The Sonority Representation of the Input /jit.naṣ.ṣat/.

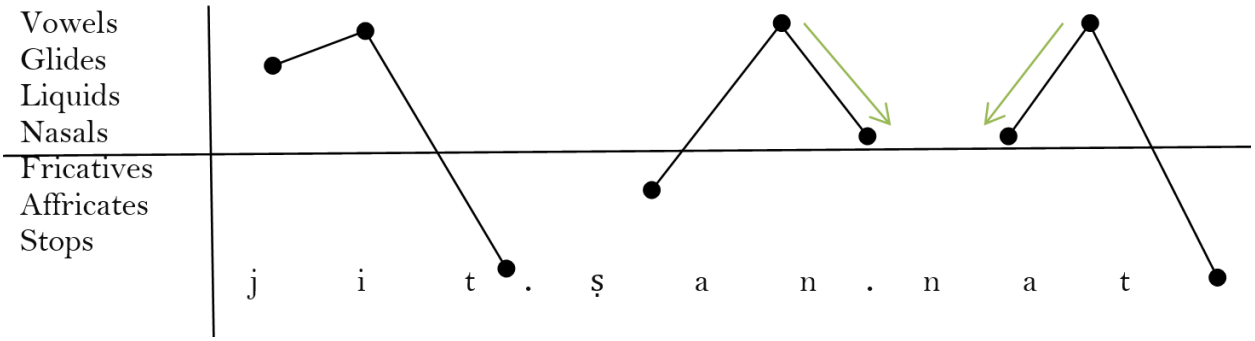

Figure 5.
The Sonority Representation of the Output [ˈjit.ṣan.nat].

Finally, in the input /ja.ˈʔas/, the laryngeal consonant /ʔ/ is positioned between two vowels, which also violates the constraint. Following metathesis, the output [ˈʔaj.jas] places the geminate glide /jj/ in the intervocalic position, thereby meeting this constraint. The figures below illustrate the sonority contrast with surrounding vowels before metathesis and its minimization after metathesis.

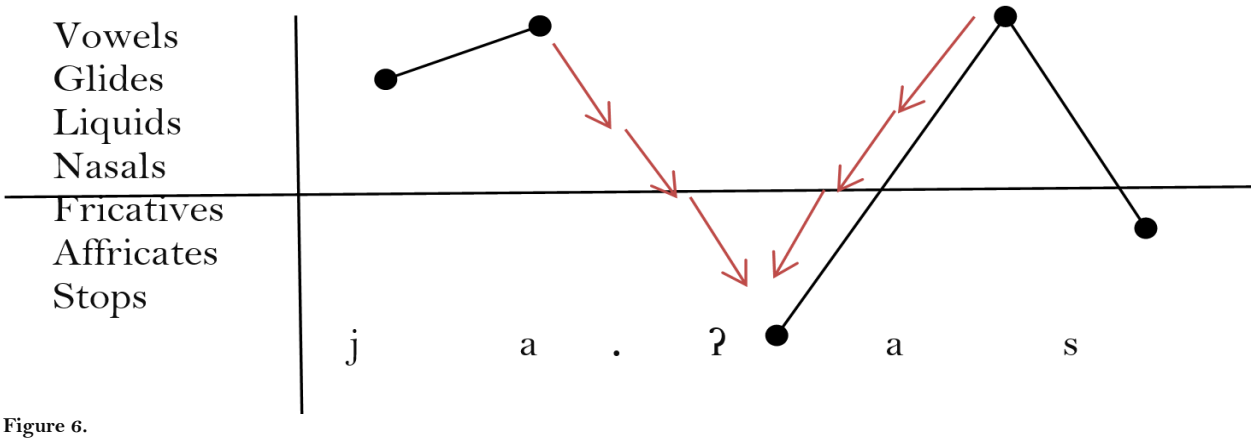

Figure 6.
The Sonority Representation of the Input /ja.ˈʔas/

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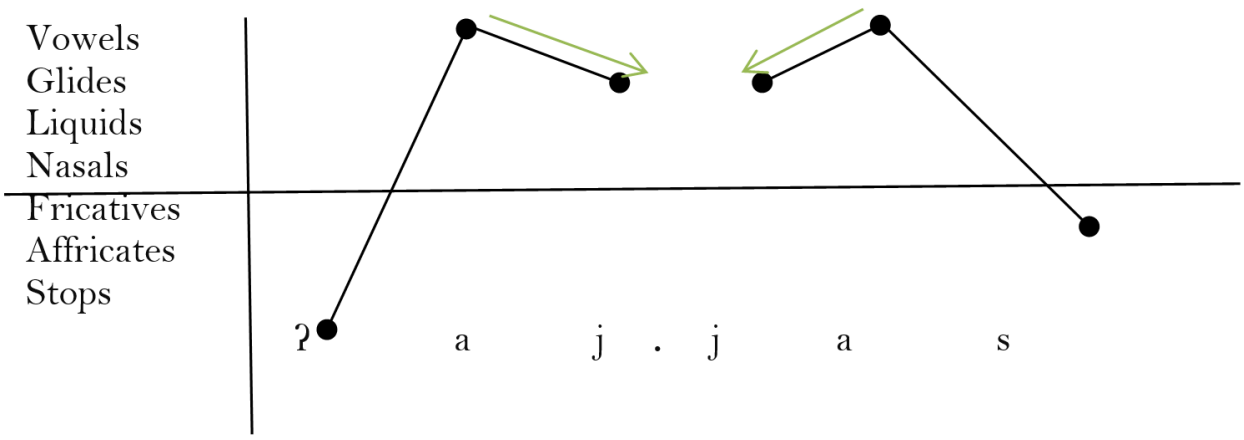

Figure 7.
The Sonority Representation of the Output [ˈʔaj.jas].

In addition to the markedness hierarchy, the relevant constraints selected for this analysis are:

- ONSET (ONS): Syllables must have onsets [2].
- *COMPLEX^{COD} (*CC]$_\sigma$): Codas are simple [7].
- AGREE[±VOICE] (AGREE[±VOI]): Adjacent segments must agree in voicing [28].
- ALIGN-LEFT[−CONTINUANT] (ALN-L[−CONT]): Every feature [−Continuant] is aligned to the left edge of the word (Based on Golston [29]).
- MAXIMALITY-INPUT-OUTPUT (MAX-IO): Every element of S_1 has a correspondent in S_2 (no deletion) [3].
- IDENTITY-INPUT-OUTPUT (IDENT-IO): Correspondent segments in S_1 and S_2 have identical values for the feature F [3].
- LINEARITY-INPUT-OUTPUT (LIN-IO): S_1 is consistent with the precedence structure of S_2, and vice versa (no metathesis) [3].

The interaction of these constraints is demonstrated in the following tableaux:

Table 3.
Mapping of /ġi.ˈṣin/ onto [ġi.ˈniṣ].

***V-V/OBS, *CC]$_\sigma$, ONS » MAX-IO, LIN-IO**					
/ġi.ˈṣin/	***V-V/OBS**	***CC]$_\sigma$**	**ONS**	**MAX-IO**	**LIN-IO**
a. [ġi.ˈṣin]	*!				
b.[ˈġiṣn]		*!		*	
c.[ġi.ˈin]			*!	*	*
☞ d. [ġi.ˈniṣ]					*

Candidate (a) is a faithful candidate but is eliminated due to a fatal violation of the highest-ranked constraint *V-V/OBS, as the obstruent /ṣ/ appears between two vowels. Candidate (b) avoids the *V-V/OBS violation but incurs a fatal violation of *CC]$_\sigma$, which disallows complex codas, leading to its elimination. Candidate (c) also resolves *V-V/OBS but violates ONS by starting the second syllable without an onset, resulting in its elimination. Candidate (d) successfully resolves *V-V/OBS by positioning the nasal /n/ intervocalically and satisfies *CC]$_\sigma$ and ONS. Although it incurs a violation of the lower-ranked constraint LIN-IO (due to metathesis), this violation is non-fatal, making Candidate (d) the optimal output.

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Table 4.
Mapping of /'jit.na.ṣat/ onto [ˈjit.ṣa.nat].

AGREE[±VOI], *V-V/OBS » IDENT-IO, LIN-IO				
/'jit.naṣ.ṣat/	AGREE[±VOI]	*V-V/OBS	IDENT-IO	LIN-IO
a. [ˈjit.naṣ.ṣat]	*!	*		
b.['jid.naṣ.sat]		*!	*	
☞ c. [ˈjit.ṣan.nat]				*

Candidate (a), a faithful candidate, incurs a fatal violation of the highest-ranked AGREE[±VOI] constraint, as the voiceless /t/ and the voiced /n/ do not match in voicing, leading to its elimination. Candidate (b) avoids the AGREE[±VOI] violation but violates *V-V/OBS by positioning the geminate obstruent /ṣṣ/ between two vowels, resulting in a fatal violation and elimination. Candidate (c) resolves the AGREE[±VOI] and *V-V/OBS violations by placing the geminate nasal /nn/ between vowels. Though it violates the lower-ranked constraint LIN-IO due to metathesis, this non-fatal violation makes Candidate (c) the optimal output.

Table 5.
Mapping of /ja.ʔas/ onto [ˈʔaj.jas].

***V-V/LAR, *V-V/OBS, ALN-L[−CONT] » IDENT-IO, LIN-IO**					
/ja.ʔas/	***V-V/LAR**	***V-V/OBS**	**ALN-L[−CONT]**	**IDENT-IO**	**LIN-IO**
a. [ja.ʔas]	*!		*		
b.[ja.saʔ]		*!	*		*
c.[sa.jaʔ]			*!		*
☞ d. [ˈʔaj.jas]				*	*

Candidate (a), a faithful candidate, is eliminated due to a fatal violation of the highest-ranked constraint *V-V/LAR, as the laryngeal /ʔ/ appears between vowels. Candidate (b) avoids this violation but incurs a fatal violation of *V-V/OBS, as the obstruent /s/ is in an intervocalic position, leading to its elimination. Candidate (c) resolves both *V-V/LAR and *V-V/OBS violations but is eliminated due to a fatal violation of ALN-L[−CONT], with the glottal stop not at the left word edge. Candidate (d) addresses both *V-V/LAR and *V-V/OBS violations by positioning the geminate glide /jj/ between vowels and satisfies ALN-L[−CONT] by placing /ʔ/ at the left edge. Although it violates IDENT-IO (from lengthening /jj/) and LIN-IO (from metathesis), these lower-ranked violations are tolerable, making Candidate (d) the optimal output.

The instances of the second pattern of non-contiguous metathesis observed in SIA are provided in the following table:

Table 6.
The Second Pattern of Non-contiguous Metathesis Found in SIA.

No.	**Original Form**	**Transcription**	**Metathesized Form**	**Transcription**	**Metathesized Sounds**	**Gloss**
1	زنجيل	/**z**an.'**dʒ**i:l/	جنزيل	/**dʒ**an.'**z**i:l/	/z/ & /dʒ/	Chain
2	زنجبيل	/**z**an.**dʒ**a.'bi:l/	جنزبيل	/**dʒ**an.**z**a.'bi:l/	/z/ & /dʒ/	Ginger
3	مزنجر	/'m**z**an.**dʒ**ir/	مينزر	/'m**j**an.**z**ir/	/z/ & /dʒ/	Rusty

In all these instances, the driving force behind metathesis is the feature agreement constraint AGREE[PLACE], which mandates that adjacent segments agree in their place of articulation. In the inputs /zan.'dʒi:l/, /zan.dʒa.'bi:l/, and /'mzan.dʒir/, the adjacent segments /n/ (which a denti-alveolar) and /dʒ/ (which is a palato-alveolar) violate the AGREE[PLACE] constraint, as they do not share the same place of articulation. By switching /z/ and /dʒ/, the outputs avoid this violation as /n/ is now positioned next to /z/, with both sharing the same place of articulation as denti-alveolar sounds.

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Further, what triggers the substitution of /dʒ/ with /j/ in the output [ˈmjan.zir] is the constraint *REVERSAL, which prohibits sonority reversals within clusters. This constraint mandates that sonority should rise towards the syllable peak in onset clusters, rather than fall. In the input /ˈmzan.dʒir/, the sonority in the onset cluster /mz-/ falls from /m/ to /z/, which violates *REVERSAL. The figures below illustrate the fall in sonority toward the syllable peak in the onset cluster before metathesis and the subsequent rise after metathesis.

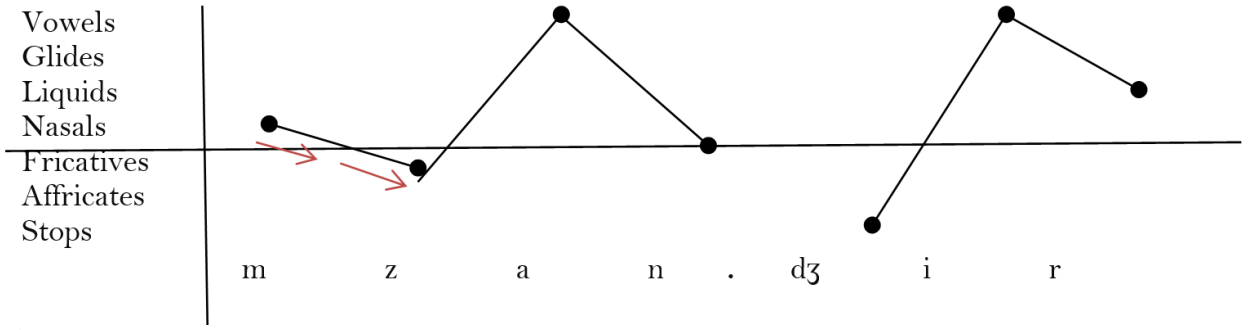

Figure 8.
The Sonority Representation of the Input /ˈmzan.dʒir/.

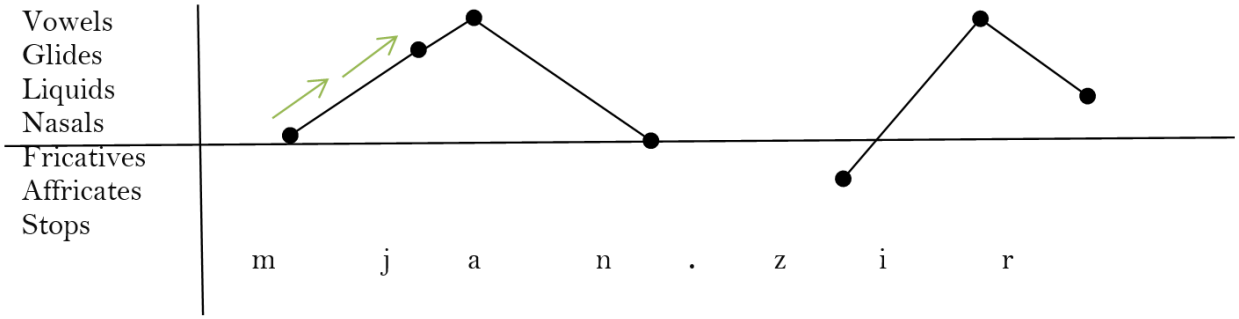

Figure 9.
The Sonority Representation of the Output [ˈmjan.zir].

In addition to the faithfulness constraints IDENT-IO and LIN-IO presented earlier, the relevant constraints selected for the analysis of these instances are as follows:

- AGREE[PLACE]: Adjacent segments must agree in their place of articulation [30].
- SYLLABLE CONTACT LAW (SYLLCON): The onset of a syllable must be less sonorous than the last segment in the immediately preceding syllable, and the greater the slope in sonority, the better [31].
- *REVERSAL(*REV): Sonority reversals are disallowed [32].

The interaction of these constraints is shown in the following tableaux:

Table 7.
Mapping of /zan.ˈdʒi:l/ onto [dʒan.ˈzi:l].

AGREE[DNT-ALV], SYLLCON » LIN-IO			
/zan.ˈdʒi:l/	**AGREE[DNT-ALV]**	**SYLLCON**	**LIN-IO**
a. [zan.ˈdʒi:l]	*!		
b.[zadʒ.ˈni:l]	*!	*	*
c.[dʒaz.ˈni:l]		*!	*
☞ d. [dʒan.ˈzi:l]			*

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Table 8.
Mapping of /zan.dʒa.'bi:l/ onto [dʒan.za.'bi:l].

AGREE[DNT-ALV], SYLLCON » LIN-IO			
/zan.dʒa.'bi:l/	**AGREE[DNT-ALV]**	**SYLLCON**	**LIN-IO**
a. [zan.dʒa.'bi:l]	*!		
b.[zadʒ.na.'bi:l]	*!	*	*
c.[dʒaz.na.'bi:l]		*!	*
☞ d. [dʒan.za.'bi:l]			*

To avoid repetition, the following analysis applies to the first two instances discussed above. Candidate (a), a faithful candidate, is eliminated due to a fatal violation of the highest-ranked constraint AGREE[DNT-ALV], as adjacent segments /n/ (a denti-alveolar) and /dʒ/ (a palato-alveolar) do not share the same place of articulation. Candidate (b) attempts to reorder /n/ and /dʒ/ but still violates AGREE[DNT-ALV,] resulting in its elimination. Candidate (c) avoids the AGREE[DNT-ALV] violation but incurs a fatal violation of SYLLCON due to a sonority rise across the syllable boundary, leading to its elimination. Candidate (d) successfully satisfies AGREE[DNT-ALV] by positioning /dʒ/ at the onset, ensuring adjacent denti-alveolars, and resolves the SYLLCON violation by maintaining a falling sonority transition between /n/ and /z/. Although it violates the lower-ranked LIN-IO due to metathesis, this is acceptable, making Candidate (d) the optimal output.

Table 9.
Mapping of /'mzan.dʒir/ onto ['mjan.zir].

AGREE[DNT-ALV], *REV » IDENT-IO, LIN-IO				
/'mzan.dʒir/	**AGREE[DNT-ALV]**	***REV**	**IDENT-IO**	**LIN-IO**
a. ['mzan.dʒir]	*!	*		
b. ['mzadʒ.nir]	*!	*		*
c.['mdʒan.zir]		*!		
☞ d. ['mjan.zir]			*	*

Candidate (a), a faithful candidate, is eliminated due to a fatal violation of the highest-ranked constraint AGREE[DNT-ALV]. Candidate (b) attempts to reorder /n/ and /dʒ/ but still violates AGREE[DNT-ALV], leading to its elimination. Candidate (c) avoids AGREE[DNT-ALV] but is eliminated due to a fatal violation of *REV, as the sonority falls from /m/ to /dʒ/ in the onset cluster. Candidate (d) resolves AGREE[DNT-ALV] by switching /z/ and /dʒ/ positions, and by substituting /dʒ/ with /j/, it avoids *REV by creating a rising sonority from /m/ to /j/. Though it violates IDENT-IO (by substituting /dʒ/ with /j/) and LIN-IO (due to metathesis), these lower-ranked violations are acceptable, making Candidate (d) the optimal output.

The instances of the third pattern of non-contiguous metathesis observed in SIA are provided in the following table:

Table 10.
The Third Pattern of Non-contiguous Metathesis Found in SIA.

No.	**Original Form**	**Transcription**	**Metathesized Form**	**Transcription**	**Metathesized Sounds**	**Gloss**
1	فانيلة	/fa:.'**n**i:**l**a/	فالينة	/fa:.'**l**i:.**n**a/	/n/ & /l/	Undershirt
2	صاعقة	/'ṣa:.**ʕ**i.**q**a/	صاقعة	/'ṣa:.**qi**.**ʕ**a/	/ʕ/ & /q/	Thunderbolt
3	يراوي	/ji.'**r**a:.**w**i:/	يواري	/ji. '**w**a:.**r**i:/	/r/ & /w/	He shows

In all these instances, the driving force behind metathesis is to prevent specific sequences of features from occurring in neighboring segments, as captured by the following constraint:

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- NO-SEQUENCE^{TIER}[F1…F2] (*SEQ^{TIER}[F1…F2]): This constraint prohibits sequences of segments with specific feature values that are adjacent on the consonantal or vowel tier, even if intervening segments are present at the root level (Bernhardt and Stemberger [33] as cited in Gerlach [34]).

Bernhardt and Stemberger [33] explain that sounds permitting continuous airflow through the oral cavity, and possibly even around the constriction, are classified as [+continuant]. This category includes vowels, glides, liquids, and fricatives. On the other hand, sounds that completely block oral airflow—such as stops, affricates, nasals, and glottal stops—are labeled as [-continuant]. Although nasals permit airflow through the nasal cavity, they still block airflow in the oral cavity, thus remaining classified as [-continuant].

In the case of /fa:.'ni:.la/, the sequence /n/ (a non-continuant) followed by /l/ (a continuant) violates the *SEQ^{TIER}[−CONT…+CONT] constraint. By switching the positions of /n/ and /l/, metathesis resolves this violation, resulting in the output [fa:.'li:.na]. Here, the sequence becomes /l/ (a continuant) followed by /n/ (a non-continuant), thus satisfying *SEQ^{TIER}[−CONT…+CONT] by eliminating the problematic sequence and ensuring that the neighboring segments /f/ and /l/ are both continuant.

In the input /'ʂa:.ʕi.qa/, the sequence /ʕ/ (a voiced) followed by /q/ (a voiceless) violates the *SEQ^{TIER}[+VOI…−VOI] constraint. Metathesis resolves this violation resulting in ['ʂa:.qi.ʕa], where the sequence is now /q/ (a voiceless) followed by /ʕ/ (a voiced). This change satisfies *SEQ^{TIER}[+VOI…−VOI], eliminating the problematic sequence and ensuring that the neighboring segments /ʂ/ and /q/ are both voiceless.

Lastly, in the input /ji.'ra:.wi:/, the sequence /r/ (a non-glide) followed by /w/ (a glide) violates the *SEQ^{TIER}[−GLI…+GLI] constraint. Switching the positions of /r/ and /w/ resolves this violation, resulting in [ji.'wa:.ri:]. The sequence becomes /w/ (a glide) followed by /r/ (a non-glide), thus satisfying *SEQ^{TIER}[−GLI…+GLI] and ensuring that the neighboring segments /j/ and /w/ are both glides.

The analysis of these instances is illustrated in the following tableaux:

Table 11.
Mapping of /fa:.'ni:.la/ onto [fa:.'li:.na].

***SEQ^{TIER}[−CONT…+CONT] » LIN-IO**		
/fa:.'ni:.la/	***SEQ^{TIER}[−CONT…+CONT]**	**LIN-IO**
a. [fa:.'ni:.la]	*!	
b.[na:.'fi:.la]	*!	*
☞ c. [fa:.'li:.na]		*

Table 12.
Mapping of /'ʂa:.ʕi.qa/ onto ['ʂa:.qi.ʕa].

***SEQ^{TIER}[+VOI…−VOI] » LIN-IO**		
/'ʂa:.ʕi.qa/	***SEQ^{TIER}[+VOI…−VOI]**	**LIN-IO**
a. ['ʂa:.ʕi.qa]	*!	
b.['ʕa:.ʂi.qa]	*!	*
☞ c. ['ʂa:.qi.ʕa]		*

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Table 13.
Mapping of /ji.'ra:.wi:/ onto [ji.'wa:.ri:].

***SEQ^{TIER}[−GLI…+GLI] » LIN-IO**		
/ji.'ra:.wi:/	***SEQ^{TIER}[−GLI…+GLI]**	**LIN-IO**
a. [ji.'ra:.wi:]	*!	
b.[ri.'ja:.wi:]	*!	*
☞ c. [ji.'wa:.ri:]		*

To avoid repetition, the following analysis applies to all three instances discussed above, as the analysis is similar across all cases. Candidate (a), a faithful candidate, incurs a fatal violation of the highest-ranked constraint *SEQ^{TIER}[F1…F2] due to a prohibited sequence on the consonantal tier, resulting in its elimination. Candidate (b) attempts to reorder segments but still violates *SEQ^{TIER}[F1…F2], leading to its elimination. Candidate (c) successfully avoids the disallowed feature sequence, satisfying *SEQ^{TIER}[F1…F2]. Although it violates the lower-ranked LIN-IO constraint due to metathesis, this non-fatal violation is acceptable, making Candidate (c) the optimal output.

The instances of the fourth and last pattern of non-contiguous metathesis observed in SIA in this study are provided in the following table:

Table 14.
The Fourth Pattern of Non-contiguous Metathesis Found in SIA.

No.	Original Form	Transcription	Metathesized Form	Transcription	Metathesized Sounds	Gloss
1	زوج	/'**z**o:**dʒ**/	يوز	/'**j**o:**z**/	/z/ &/dʒ/	Pair
2	أزواج	/ʔa**z**.'wa:**dʒ**/	أيواز	/ʔa**j**.'wa:**z**/	/z/ &/dʒ/	Pairs

In these two instances, the driving force behind metathesis is the alignment constraint ALN-L[−CONT], introduced earlier, which requires the alignment of non-continuant segments to the left edge of the word. In the inputs /'zo:dʒ/ and /ʔaz.'wa:dʒ/, the segment /dʒ/, which has the feature [−continuant], occurs at the right edge of the word, thus violating this constraint. Metathesis repositions the non-continuant consonant /dʒ/ to the left edge of the word to satisfy this constraint.

Moreover, the substitution of /dʒ/ with /j/ in the outputs ['jo:z] and [ʔaj.'wa:z] ensures that adjacent segments share the same feature values, as mandated by the following constraint:

- SHARE[FEATURE] (SHARE[F]): Adjacent segments must share the same value for feature [F] [35].

The substitution of /dʒ/ with /j/ in the output ['jo:z] is motivated by the constraint SHARE[±CONT], ensuring that both adjacent segments /j/ and /o:/ share the feature [+CONTINUANT]. In the output [ʔaj.'wa:z], the substitution is driven by the constraint SHARE[±SON], so that both adjacent segments /j/ and /w/ share the feature [+SONORANT].

In addition to the constraints ALN-L[−CONT] and SHARE[F], the faithfulness constraints IDENT-IO and LIN-IO, introduced earlier, are also included in the analysis of these two instances. The interaction of these constraints is illustrated in the following tableaux.

Table 15.
Mapping of /'zo:dʒ/ onto ['jo:z].

ALN-L[-CONT], SHARE[±CONT] » IDENT-IO, LIN-IO				
/'zo:dʒ/	**ALN-L[-CONT]**	**SHARE[±CONT]**	**IDENT-IO**	**LIN-IO**
a. ['zo:dʒ]	*!	*		
b.['dʒo:z]		*!	*	*
☞ c. ['jo:z]			**	*

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Table 16.
Mapping of /ʔaz.'wa:dʒ/ onto [ʔaj.'wa:z]

ALN-L[−CONT], SHARE[±SON] » IDENT-IO, LIN-IO				
/ʔaz.'wa:dʒ/	**ALN-L[−CONT]**	**SHARE[±SON]**	**IDENT-IO**	**LIN-IO**
a. [ʔaz.'wa:dʒ]	*!	*		
b. [ʔadʒ.'wa:z]		*!		*
☞ c. [ʔaj.'wa:z]			*	*

Similar to the previous patterns, the following analysis applies to both instances discussed above. Candidate (a), a faithful candidate, is eliminated due to a fatal violation of the highest-ranked constraint ALN-L[−CONT], as the non-continuant /dʒ/ occurs at the word's left edge. Candidate (b) resolves this by aligning /dʒ/ at the left edge but incurs a fatal violation of SHARE[F] constraint, as adjacent segments lack shared feature values, leading to its elimination. Candidate (c) addresses both ALN-L[−CONT] and SHARE[F] violations by substituting /dʒ/ with the continuant /j/ and aligning it at the left edge of the word. While it violates IDENT-IO (for substituting /dʒ/ with /j/) and LIN-IO (due to metathesis), these non-fatal, lower-ranked violations make Candidate (c) the optimal output.

8. Conclusions

To conclude, this study has examined the phonological process of non-contiguous metathesis in SIA. The primary aims were to test the capability of OT in accounting for non-contiguous metathesis in SIA and to identify what triggers this phonological process. The analysis demonstrates that OT effectively explains non-contiguous metathesis in SIA, providing a satisfactory account of all instances identified in the study. The findings reveal four distinct patterns of non-contiguous metathesis in SIA, each driven by specific constraints: the first pattern is governed by sonority-related constraints, the second by feature agreement constraints, the third by sequential constraints, and the fourth by alignment constraints. These results suggest that, in SIA, resolving marked structures of the language is prioritized over preserving the linear order of segments. Future studies might consider applying alternative phonological theories, such as rule-based approaches, to compare results and further investigate how different frameworks account for non-contiguous metathesis in SIA.

Transparency:

The authors confirm that the manuscript is an honest, accurate, and transparent account of the study; that no vital features of the study have been omitted; and that any discrepancies from the study as planned have been explained. This study followed all ethical practices during writing.

References

[1] E. Hume, "Metathesis in phonological theory: The case of Leti," Unpublished Doctoral Dissertation. Ohio State University, Columbus, OH, USA, 1997.

[2] A. Prince and P. Smolensky, *Optimality theory: Constraint interaction in generative grammar*. Malden, MA, USA: Blackwell Publishing, 2004.

[3] J. McCarthy and A. Prince, *Faithfulness and reduplicative identity. In J. Beckman, S. Urbanczyk, & L. Walsh (Eds.), University of Massachusetts Occasional Papers in Linguistics 18: Papers in Optimality Theory*. Amherst, MA, USA: Graduate Linguistic Student Association, 1995.

[4] J. McCarthy and A. Prince, *Prosodic morphology I: Constraint interaction and satisfaction (Ms.). University of Massachusetts, Amherst, and Rutgers University*. Cambridge, MA, USA: MIT Press, 1993a.

[5] J. McCarthy and A. Prince, *Generalized alignment. In G. Booij & J. van Marle (Eds.), Yearbook of Morphology*. Dordrecht, The Netherlands: Kluwer, 1993b.

[6] J. McCarthy and A. Prince, "The emergence of the unmarked: Optimality in prosodic morphology. In M. G. (Ed.)," in *Proceedings of the North East Linguistic Society 24 (pp. 333–379). GLSA Publications. ROA-13*, 1994a.
[7] R. Kager, *Optimality theory*. Cambridge, UK: Cambridge University Press, 1999.
[8] J. McCarthy, *Doing optimality theory: Applying theory to data*. Malden, MA, USA: Blackwell Publishing, 2008.
[9] E. C. Zsiga, *The sounds of language: An introduction to phonetics and phonology*. Malden, MA, USA: John Wiley & Sons, 2013.
[10] A. Cooper, *Reconciling Indo-European syllabification*. Leiden, Netherlands: Brill, 2015.
[11] P. Smolensky, "The initial state and "richness of the base" in Optimality Theory (Technical Report No. 293)," Rutgers Optimality Archive, 1996.
[12] A. Prince and P. Smolensky, "Optimality theory in phonology," Unpublished Manuscript. Rutgers University and Johns Hopkins University, 2002.
[13] A. Prince and P. Smolensky, "Optimality: From neural networks to universal grammar," *Science*, vol. 275, no. 5306, pp. 1604-1610, 1997.
[14] J. J. McCarthy, "What is optimality theory? 1," *Language and Linguistics Compass*, vol. 1, no. 4, pp. 260-291, 2007.
[15] E. Hume, *Metathesis: Formal and functional considerations. In E. Hume et al. (Eds.), Surface syllable structure and segment sequencing*. Utrecht, The Netherlands: Holland Institute of Generative Linguistics, 2001.
[16] W. Leslau, *Gurage studies: Collected articles*. Wiesbaden, Germany: Otto Harrassowitz Verlag, 1992.
[17] K. Al-Ani and N. Al-Birazy, *Geography of Iraq*. Baghdad, Iraq: University of Baghdad, 1979.
[18] J. Peoples and G. Bailey, *Humanity: An introduction to cultural anthropology*. Belmont, CA: Cengage Learning, 2012.
[19] M. A. Abdul Sattar, "A contrastive study of consonant clusters in Standard English and Iraqi Arabic," Unpublished Master's Thesis. University of Basrah, 1989.
[20] R. Benyoucef and R. Mahadin, "Phonological processes in Algerian Arabic as spoken in Mostaganem: An optimality perspective," *Research on Humanities and Social Sciences*, vol. 3, no. 14, pp. 85-100, 2013.
[21] M. S. M. Alqahtani, "Syllable structure and related processes in optimality theory: An examination of Najdi Arabic," Doctoral Dissertation. Newcastle University, 2014.
[22] Y. M. Elramli, "Metathesis in Libyan Arabic," *International Journal of Technical Research and Applications*, vol. 2, no. 7, pp. 71–74, 2014.
[23] R. Habib, "Metathesis in Syrian Arabic: Types and conditioning factors," *Journal of Universal Language*, vol. 23, no. 1, pp. 1-34, 2022. https://doi.org/10.22425/jul.2022.23.1.1
[24] O. Idrissi, "Metathesis in Moroccan Arabic: Optimality-theoretic account," *International Journal of Linguistics Studies*, vol. 3, no. 1, pp. 62-67, 2023. https://doi.org/10.32996/ijls.2023.3.1.3
[25] T. Jasim and K. Sharhan, "Phonological metathesis in Iraqi Arabic dialect: A synchronic perspective," *Journal of the College of Languages*, vol. 26, pp. 1–24, 2013.
[26] C. Uffmann, "Intrusive [r] and optimal epenthetic consonants," *Language Sciences*, vol. 29, no. 2-3, pp. 451-476, 2007. https://doi.org/10.1016/j.langsci.2006.12.017
[27] E. Selkirk, *On the major class features and syllable theory. In M. Aronoff & R. Oehrle (Eds.), Language sound structure*. Cambridge, MA: MIT Press, 1984.
[28] Z. Nagy, "Consonantal voicing assimilations and the double nature of [voice]," RuLing Papers, 2, Rutgers University, 2000, 2000.
[29] C. Golston, "Direct optimality theory: Representation as pure markedness," *Language*, vol. 72, no. 4, pp. 713-748, 1996.
[30] J. Alderete, J. Beckman, L. Benua, A. Gnanadesikan, J. McCarthy, and S. Urbanczyk, "Reduplication with fixed segmentism," *Linguistic Inquiry*, vol. 30, no. 3, pp. 327-364, 1999.
[31] O. Bat-El, "Selecting the best of the worst: The grammar of Hebrew blends," *Phonology*, vol. 13, no. 3, pp. 283-328, 1996.
[32] F. Morelli, *The relative harmony of /s+stop/ onsets: Obstruent clusters and the sonority sequencing principle*. Cambridge, UK: Cambridge University Press eBooks, 2003.
[33] B. Bernhardt and J. P. Stemberger, *Handbook of phonological development: From the perspective of constraint-based nonlinear phonology*. San Diego: Academic Press, 1998.
[34] S. R. Gerlach, "The acquisition of consonant feature sequences: Harmony, metathesis and deletion patterns in phonological development," Doctoral Dissertation. University of Minnesota, 2010.
[35] J. J. McCarthy, *Doing optimality theory: Applying theory to data*. Malden, MA: Wiley-Blackwell, 2011.

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