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PROSODIC CONSTRAINTS ON REDUPLICATION IN SAUDI ARABIC: A TYPOLOGICAL AND THEORETICAL INVESTIGATION

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ABSTRACT

This study investigates the prosodic mechanisms that shape reduplication in Saudi Arabic, a phenomenon that remains underexplored within Arabic dialectology despite its theoretical significance for prosodic morphology. While prior research has established that reduplication across languages often obeys weight- or foot-based constraints, little is known about how such prosodic structures operate in Saudi Arabic. Adopting an Optimality Theory (OT) framework, this study examines whether Saudi Arabic reduplication conforms primarily to bimoraic or metrical-foot-based restrictions and how these constraints interact with syllable weight. A corpus of 538 tokens, complemented by elicited speech data and real-time perception experiments, was analyzed to assess both production and processing patterns. Results indicate that reduplication overwhelmingly conforms to bimoraic constraints (82.3%), with metrical-foot alignment exerting a secondary influence (14.7%). Light syllables undergo modification significantly more often than heavy ones ($\chi^2(2, N = 538) = 96.4$, $p < .001$), suggesting weight-sensitive constraint ranking. Perception data further demonstrate that listeners process bimoraic, stress-aligned reduplicants more efficiently than forms that violate these constraints, confirming the cognitive reality of the hierarchy. The findings refine existing models of prosodic morphology by linking grammatical and processing evidence and position Saudi Arabic as a typologically strict system within Semitic phonology. Implications extend to theoretical linguistics and computational modeling of prosodic patterns in morphophonology.

KEYWORDS: Arabic Phonology, Metrical Structure, Morphological Reduplication, Optimality Theory, Prosodic Constraints, Reduplication Typology, Saudi Arabic, Syllable Weight.

1. INTRODUCTION

Reduplication—repeating a word or part of it to create grammatical, semantic, or phonological meaning—is a universal linguistic process that offers deep insight into the interaction between morphology, phonology, and cognition. Across languages, reduplication signals functions as varied as plurality, aspect, intensification, and lexical creativity (Moravcsik, 1978; Rubino, 2013). For phonologists and morphologists, it presents a window into the internal architecture of the word and the rhythmic principles that govern speech production. Within the Arabic language family, reduplication occupies a particularly intriguing space: it contributes to expressive morphology and lexical innovation, yet remains theoretically underanalyzed, especially in dialectal contexts such as Saudi Arabic. Understanding how prosodic constraints shape reduplication in this variety is essential for both typological classification and broader theoretical modeling of Semitic morphophonology.

In recent decades, linguistic theory has witnessed a growing convergence between structural and cognitive approaches to prosody. Frameworks such as Prosodic Morphology (McCarthy & Prince, 1995) and Optimality Theory (OT) (Prince & Smolensky, 2004) have reconceptualized reduplication as an interaction of competing constraints rather than fixed templates. Within OT, surface forms are optimal resolutions of conflicts among constraints on syllable structure, stress alignment, and morphological realization. Yet despite the explanatory power of this model, most OT-based research on Arabic prosody has centered on Classical Arabic and a few well-documented dialects, notably Egyptian, Levantine, and Yemeni (Watson, 2002; Davis & Zawaydeh, 2001). Saudi Arabic, by contrast, remains largely uncharted territory, even though it offers fertile ground for testing how prosodic systems behave under regional and social variation.

A central paradox frames the current investigation. On the one hand, Arabic dialects share a common prosodic skeleton—root-and-pattern morphology, templatic syllable structures, and predictable stress patterns. On the other, empirical observations suggest subtle yet systematic deviations among dialects in how reduplication interacts with syllable weight and metrical footing. These discrepancies raise an unresolved theoretical question: are the prosodic constraints governing reduplication universal across Arabic dialects, or do they exhibit dialect-specific rankings and weight effects? Addressing this tension has implications beyond Arabic phonology; it bears on how universal grammatical principles accommodate gradient, usage-based variation across speech communities.

Previous studies have hinted at the relevance of prosodic factors but have not provided a systematic, quantitative account. Watson (2002) described reduplication in Cairene and Sanʿani Arabic, noting its sensitivity to syllable weight, while Benmamoun (2018) discussed morphological reduplication across Semitic languages without exploring its prosodic underpinnings. Al-Mozainy (2020) briefly referenced reduplicative forms in Saudi Arabic but did not analyze the constraints governing their formation. Consequently, the interaction between bimoraicity, metrical structure, and morphological copying in Saudi Arabic remains an open problem. Filling this gap requires integrating corpus evidence, elicited speech data, and psycholinguistic testing to reveal not only what speakers produce but also how they process these patterns cognitively.

The theoretical lens adopted here is Optimality Theory, which models language as a system of ranked constraints. This study focuses on the relative prominence of three constraints: BIMORAICITY (requiring minimal weight for prosodic constituents), ALIGN-FT-L (aligning reduplicants with metrical feet), and PARSE-SYL (ensuring syllable inclusion within prosodic structures). In languages such as Tagalog and Swahili, these constraints have been shown to interact hierarchically, shaping reduplicative outcomes (Kager, 1999; Yu, 2007). By applying OT to Saudi Arabic, this study tests whether the ranking BIMORAICITY ≫ ALIGN-FT-L ≫ PARSE-SYL can explain observed distributional and perceptual patterns. Importantly, the framework allows the investigation to bridge grammatical description and psycholinguistic reality—linking formal structure with processing evidence.

The study proceeds from the assumption that prosodic constraints are not merely formal devices but also reflect cognitive preferences in speech perception and production. Recent advances in experimental phonology have underscored the need to test whether theoretical constraints correspond to actual processing biases (Hayes & Wilson, 2008; Moreton & Pater, 2012). If Saudi Arabic speakers process bimoraic, stress-aligned reduplicants more efficiently than those violating such constraints, it would provide empirical support for the psychological validity of the OT hierarchy. This dual theoretical-empirical approach situates the study within the emerging field of experimental prosodic morphology, where formal models are evaluated through behavioral evidence.

Accordingly, this research pursues four objectives:

1. To identify the prosodic constraints that govern reduplication in Saudi Arabic, emphasizing the relative roles of bimoraicity and metrical-foot alignment.
2. To examine how syllable weight—light (CV), heavy (CVC, CVV), and superheavy (CVVC, CVCC)—influences the likelihood of reduplication and constraint satisfaction.
3. To compare Saudi Arabic with typologically related and unrelated languages to determine whether its constraint hierarchy is dialect-specific or typologically consistent.
4. To test the cognitive reality of prosodic constraints by evaluating whether listeners show processing advantages for reduplicants that conform to the predicted hierarchy.

These objectives yield the following research questions:

1. What prosodic constraints govern reduplication in Saudi Arabic, and how are they hierarchically ranked within an OT framework?
2. How does syllable weight interact with these constraints to influence reduplicative patterns?
3. To what extent does Saudi Arabic align with or diverge from cross-linguistic typologies of prosodic morphology?
4. Do Saudi Arabic listeners exhibit cognitive sensitivity to constraint satisfaction in real-time perception tasks?

By addressing these questions, the study aims to bridge a gap between descriptive dialectology, formal phonological theory, and psycholinguistic validation. It refines the understanding of constraint interaction in a Semitic language that has been largely overlooked and contributes to ongoing debates on the universality of prosodic hierarchies. Moreover, the findings have broader implications for computational modeling of Arabic speech and for developing speech technologies that accommodate dialectal variation in prosody.

The paper proceeds as follows. Section 2 reviews relevant literature on prosodic morphology, syllable weight, and reduplication across languages, highlighting the gap in Saudi Arabic research. Section 3 outlines the methodological framework, including corpus compilation, elicitation procedures, and perceptual testing. Section 4 presents quantitative and experimental findings. Section 5 discusses theoretical implications for OT and prosodic morphology, and Section 6 concludes with recommendations for future phonological and computational studies.

2. LITERATURE REVIEW

Reduplication has been widely studied in phonology and morphology, especially in work linking copying to prosodic well-formedness and typological patterns (e.g., Moravcsik, 1978; McCarthy & Prince, 1995; Hyman, 2006). This review focuses on prosodic constraints on reduplicant shape, the roles of moraic structure and metrical footing, and the suitability of Optimality Theory for modeling these interactions. Despite extensive research on Arabic phonology, the prosodic conditioning of reduplication in Saudi Arabic remains underdescribed.

2.1. Prosodic Constraints in Reduplication

Reduplication has long provided a testing ground for theories of prosodic structure, since it exposes how morphological copying interacts with phonological well-formedness. Within prosodic morphology, the shape of a reduplicant is governed not by arbitrary templates but by constraints derived from the language's prosodic hierarchy (McCarthy & Prince, 1995; Kager, 1999). This hierarchy organizes linguistic material into syllables, feet, prosodic words, and higher domains, with each level imposing its own weight and alignment requirements. Cross-linguistic evidence indicates that reduplication typically conforms to minimal size restrictions, often a bimoraic or metrical-foot structure (Hyman, 2006; Alderete & Kochetov, 2017). For instance, Austronesian and Bantu languages frequently limit reduplicants to minimal prosodic words, while Indo-European languages often favor foot-aligned structures (Inkelas & Zoll, 2007; Gordon, 2016).

Within this theoretical frame, reduplication reflects a competition between faithfulness constraints, which preserve input segments, and markedness constraints, which enforce prosodic well-formedness (Prince & Smolensky, 2004). The relative ranking of these constraints explains variation across languages: some prioritize preserving morphological identity, while others prioritize rhythmic or weight-based harmony. Crucially, this perspective shifts the analysis from categorical rules to *gradient constraint satisfaction*, enabling formal models to capture dialectal variation and optionality.

The weight of the syllable—the number of moras it carries—emerges as a decisive factor in determining reduplicant form. McCarthy and Prince (1995) argued that reduplicants must be minimally bimoraic, ensuring phonological stability across morphophonemic operations. Later studies

expanded on this idea, showing that syllable weight correlates with stress assignment (Hayes, 1995) and with the minimal word condition in many languages (Gordon, 2002). Consequently, languages tend to favor reduplicants that satisfy bimoraicity and align with foot boundaries, producing rhythmic and perceptually balanced outcomes.

These prosodic principles, however, interact differently across linguistic families. In some systems, moraic constraints dominate, while in others, metrical-foot alignment overrides them. For example, Frampton (2009) demonstrated that in Tagalog, the reduplicant aligns with a trochaic foot regardless of mora count, whereas in Bantu and Austronesian languages, moraic minimality prevails (Downing, 2006; Yu, 2007). These differences raise an essential typological question: how do prosodic constraints vary across languages sharing similar morphological architectures but divergent prosodic systems? The current study extends this inquiry to the underexplored case of Saudi Arabic.

2.2. Reduplication In Arabic and Semitic Phonology

Arabic reduplication represents a particularly complex domain, as it operates within a root-and-pattern morphological system where consonantal roots combine with prosodic templates to yield surface forms (Broselow, 1992; Watson, 2002). Across Arabic dialects, reduplication serves multiple functions—intensification, plurality, lexical derivation, and expressive emphasis (Versteegh, 2014)—but its prosodic conditioning has received uneven attention.

Research on Egyptian and Levantine Arabic has shown that reduplication often respects bimoraic minimality. Broselow (1992) observed that in Cairene Arabic, partial reduplication rarely violates moraic constraints, even when lexical factors invite deviation. Davis and Zawaydeh (2001) found similar patterns in Jordanian Arabic, where reduplication interacts predictably with stress rules and syllable structure. However, these findings cannot automatically be extended to Saudi Arabic, whose phonological profile differs in terms of vowel length, gemination, and metrical rhythm (Al-Mozainy, 2020).

Comparative studies across Arabic dialects have revealed subtle prosodic divergence. Watson (2002) demonstrated that Yemeni Arabic exhibits stricter moraic constraints than Levantine varieties, while Benmamoun (2018) noted that North African dialects allow greater prosodic flexibility in expressive reduplication. These differences likely stem from variations in metrical footing and syllable typology across dialects (Holes, 2004). Yet despite abundant descriptive data, the interaction between prosodic hierarchy and reduplication in Saudi Arabic remains undocumented. Al-Mozainy (2020) mentioned instances of partial reduplication in Najdi Arabic, but without a systematic analysis of the constraint interactions governing these forms.

Within Semitic linguistics more broadly, the study of reduplication has focused largely on Hebrew and Classical Arabic (Ussishkin, 2000; Kiparsky, 2003). These languages exhibit templatic reduplication that adheres closely to foot-based structures, but dialectal varieties tend to deviate from such strict templatic regularity. As a result, the theoretical generalizations derived from Classical Arabic may not capture the full range of prosodic variation in modern dialects. Saudi Arabic thus provides a fertile testing ground for whether constraint rankings are universally stable or contextually adaptive—a question central to modern phonological theory.

2.3. Optimality Theory and Constraint Interaction

The advent of Optimality Theory (OT) revolutionized the analysis of reduplication by replacing rule-based derivations with ranked constraints that compete to produce the optimal output (Prince & Smolensky, 2004). In OT, reduplication reflects the resolution of conflict between faithfulness (MAX-IO, DEP-IO) and markedness constraints (BIMORAICITY, ALIGN-FT-L, PARSE-SYL). This approach allows for cross-linguistic comparison by assuming that the same universal constraint set underlies all languages, while variation arises from differences in ranking.

Empirical studies have applied OT to model reduplication across diverse languages—Tagalog (Inkelas & Zoll, 2007), Fijian (Alderete et al., 1999), and Yoruba (Kager, 1999)—demonstrating how constraint reranking accounts for typological diversity. Within Arabic, however, OT analyses have been uneven. McCarthy and Prince (1995) primarily modeled Classical Arabic templates, focusing on derivational patterns such as CaCaC and CiCaaC. Subsequent work by Ussishkin (2000) extended OT to Modern Hebrew but did not explore dialectal Arabic variation.

Applying OT to Arabic reduplication offers distinct theoretical advantages. First, it allows formalizing the interaction between bimoraic constraints and metrical alignment, two forces that frequently compete in shaping reduplicative outcomes. Second, OT provides a mechanism for

explaining partial reduplication and variable truncation, phenomena that rule-based approaches struggle to accommodate. Third, OT's violable constraints facilitate modeling of gradient acceptability and processing variation, bridging linguistic form and cognitive perception.

Nonetheless, existing OT analyses of Arabic often stop short of empirical validation. Few studies have tested whether the predicted constraint hierarchies correspond to speakers' intuitive or perceptual judgments. Recent advances in experimental phonology (Hayes & Wilson, 2008; Moreton & Pater, 2012) highlight the importance of testing theoretical predictions against behavioral evidence. By integrating OT with psycholinguistic methods—such as acceptability judgments and lexical decision tasks—researchers can determine whether constraint rankings have cognitive reality. This integration marks a methodological shift toward experimental validation of prosodic theories, one that the present study seeks to advance.

2.4. Psycholinguistic Evidence for Prosodic Constraints

Traditional prosodic theory has often treated constraint hierarchies as purely formal constructs. However, experimental studies increasingly suggest that prosodic structure influences speech perception, lexical access, and memory (Cutler, 2015; Dupoux et al., 2011). Phonological well-formedness judgments, reaction times, and eye-tracking data reveal that listeners are sensitive to moraic balance and metrical regularity during word recognition. For example, Cutler and Norris (1988) demonstrated that English listeners detect stress-aligned patterns more efficiently, while Otake et al. (1993) found comparable sensitivity to moraic rhythm in Japanese.

In the Semitic context, psycholinguistic testing remains rare. A few studies—such as Al-Tamimi (2018) on Jordanian Arabic—suggest that native speakers implicitly favor prosodically well-formed constructions. Yet no systematic study has examined whether Arabic listeners process reduplicants that conform to bimoraic and stress-aligned constraints more efficiently than those violating them. Addressing this question is critical for bridging the divide between formal grammar and mental representation.

If perception mirrors grammar, then constraint hierarchies posited by OT should manifest as measurable differences in processing efficiency. Conversely, if no such correlation appears, the psychological validity of these hierarchies would require reevaluation. Thus, psycholinguistic experimentation serves not only as a methodological complement but also as a theoretical test of the cognitive grounding of phonological structure. The present study adopts this dual approach—analyzing production and perception—to evaluate whether prosodic constraints have both grammatical and cognitive force in Saudi Arabic reduplication.

2.5. Theoretical Integration and Research Gap

The synthesis of prior research reveals three converging insights. First, reduplication universally interacts with prosodic structure, but the exact balance between bimoraicity and metrical alignment varies across languages. Second, Arabic dialects exhibit rich reduplicative behavior, yet the prosodic basis of this variation—particularly in Saudi Arabic—remains poorly documented. Third, while Optimality Theory provides a robust formal account of constraint ranking, empirical evidence validating these rankings in Arabic is scarce.

Against this backdrop, the present study advances the field in two crucial ways. Theoretically, it extends the OT model by proposing and testing a hierarchy in which BIMORAICITY outranks ALIGN-FT-L and PARSE-SYL, reflecting the primacy of weight-based constraints in Saudi Arabic. Empirically, it introduces psycholinguistic validation—through real-time perception experiments—to examine whether the grammar's predicted constraint rankings align with speakers' processing biases.

This dual contribution positions the study at the intersection of theoretical phonology, typology, and experimental linguistics. By integrating corpus-based and behavioral evidence, it not only fills a long-standing descriptive and theoretical gap in Arabic reduplication research but also contributes to broader debates on how formal constraint hierarchies map onto cognitive processes. Ultimately, the findings aim to refine our understanding of the prosody–morphology interface and illustrate how linguistic theory can be anchored in experimentally grounded evidence.

3. METHODOLOGY

3.1. Design And Rationale

The study adopted a two-stage mixed-methods design integrating (i) a quantitative analysis of naturally occurring and elicited instances of reduplication in Saudi Arabic and (ii) psycholinguistic experiments to test the cognitive reality of the proposed constraint hierarchy. The production component identified the distribution of reduplication patterns and their prosodic

conditioning, while the perception component examined whether listeners process prosodically well-formed reduplicants more efficiently than ill-formed ones. This design was theoretically motivated by Optimality Theory (OT): distributional patterns reveal grammatical constraint rankings, whereas behavioral measures capture processing correlates of constraints such as BIMORAICITY, ALIGN-FT-L, and PARSE-SYL. Accordingly, the study tested whether the ranking BIMORAICITY ≫ ALIGN-FT-L ≫ PARSE-SYL accounts for the observed distributional and perceptual patterns (see Figure 1 for a schematic representation of this constraint hierarchy within the prosodic structure)

BIMORAICITY » ALIGN-FT-L » PARSE-SYL

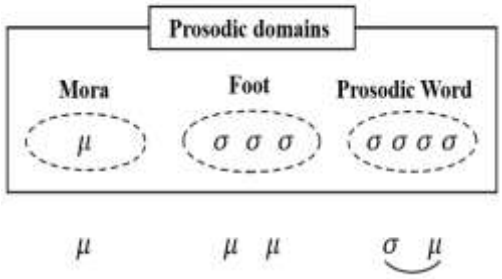

Figure 1: Prosodic Hierarchy and Proposed OT Ranking (BIMORAICITY ≫ ALIGN-FT-L ≫ PARSE-SYL) Linking Moraic Structure, Foot Parsing, And the Prosodic Word.

3.2. Participants And Context

Corpus and sampling. The corpus comprised 538 reduplicated tokens drawn from semi-structured interviews and spontaneous conversations recorded in Central/Najdi Saudi Arabia (Riyadh region) between January 2023 and December 2024, representing mostly informal everyday speech. A token was defined as one occurrence of a reduplicated item with a clearly segmentable reduplicant and unambiguous syllabification. Hesitation or repair replays were excluded, and only the first occurrence per speaker per reduplicated form was retained. Tokens were excluded when the audio or context did not allow reliable prosodic parsing (e.g., noise or overlap, unclear segmentation, ambiguous weight or prominence, or code-switching affecting the target form).

Dialectal scope. The data represent Central (Najdi) Saudi Arabic, drawn primarily from speakers with long-term residence in the Riyadh region. To minimize dialect mixing, we included only speakers who self-identified as Najdi, grew up in the Central region, and reported Najdi Arabic as their primary variety used in daily home communication.

Participants. The study involved two complementary participant groups. The production sample consists of the speakers represented in the corpus and in controlled elicitation, comprising native speakers aged 20–50. The tokens span adjectives, nouns, verbs, and fixed expressions, enabling comparisons across word classes. For descriptive analyses, speakers were grouped into three age brackets (20–30, 31–40, 41–50), consistent with the reporting in the Results section.

The perception sample consisted of adult native speakers of Central/Najdi Saudi Arabic with normal hearing and no reported speech or language disorders. Participants were recruited through university mailing lists and community networks to complete psycholinguistic tasks designed to test whether prosodically well-formed reduplicants (bimoraic and stress-aligned) are processed more efficiently than ill-formed counterparts.

Setting and procedure. Production data were collected over several months through corpus recording and controlled elicitation in quiet rooms using studio-quality headsets. Perception sessions were conducted in a sound-attenuated laboratory using calibrated headphones and lasted approximately 35–45 minutes, including consent, practice, and debriefing. Recruitment followed institutional review procedures; all volunteers provided written consent prior to participation and received a small gift card as compensation, in line with local ethical standards.

3.3. Materials And Instruments

The corpus and elicitation materials included media transcripts, normalized social media text, and published prose containing instances of reduplication. Elicitation prompts were carefully designed to elicit lexical items varying in syllable weight (CV, CVC/CVV, CVVC/CVCC) and metrical position. All items were screened to exclude low-frequency or highly idiomatic forms unless they were intentionally analyzed as "deviations" (e.g., loanwords), which were explicitly tracked in the

analysis. As detailed in the results, the data were classified by prosodic structure—bimoraic, foot-aligned, or non-conforming—and by morphological category, including adjectives, nouns, verbs, and expressions.

The elicited productions were recorded at a sampling rate of 44.1 kHz using high-quality audio equipment to ensure precise acoustic capture. Two trained phoneticians independently segmented and annotated each reduplicant in Praat, following standardized labeling conventions for onset, nucleus, and coda boundaries. Any discrepancies in segmentation or prosodic labeling were resolved through joint review and consensus discussion to maintain annotation consistency and reliability across the dataset.

The perception component employed two complementary tasks designed to test the cognitive reality of the proposed constraint hierarchy. In the speeded acceptability judgment task (120 trials, 4-point scale), participants rated auditory tokens that either conformed to or violated the predicted prosodic constraints—bimoraicity and foot alignment. In the auditory lexical decision task (160 trials), they determined whether each auditory stimulus represented a real Saudi Arabic word or expression, with both reaction time and accuracy recorded. Together, these tasks assessed whether prosodically well-formed reduplicants are processed more efficiently than ill-formed ones.

To ensure reliability and validity, several procedures were followed. Inter-annotator reliability was established by double-coding 20% of the data; discrepancies were discussed and resolved before full annotation. Stimulus validation involved a pilot study ($n \approx 12$) to eliminate items with segmental irregularities, ambiguous lexical status, or unstable prosody, retaining only stimuli with clear category membership. Task calibration included practice trials to confirm comprehension, while outlier responses were logged and examined to monitor possible speed–accuracy trade-offs.

3.4. Procedure

The first stage of the study combined corpus analysis and elicited data to capture the full range of reduplication patterns in Saudi Arabic. The corpus was compiled from diverse sources and transcribed according to a unified orthographic scheme to ensure consistency across registers. During elicitation, participants produced target items within sentence frames designed to elicit natural speech under neutral focus conditions, minimizing contextual or pragmatic bias. Each token was then coded for reduplication type (full or partial), syllable weight (light, heavy, or superheavy), and prosodic conformity (bimoraic, foot-aligned, or non-conforming). As reported in the results, bimoraic reduplication predominated (82.3%), with metrical-foot alignment accounting for 14.7% and only 3.0% classified as non-conforming. Tokens were also cross-referenced by morphological category—adjectives, nouns, verbs, and expressions—revealing that partial reduplication slightly outnumbered full reduplication, with adjectives emerging as the most frequent category. Finally, tokens that violated expected prosodic patterns were tagged for source type, such as loanwords, specialized items, or idioms. Most deviations clustered in loanwords, indicating that exceptions resulted from lexical borrowing rather than grammatical instability.

The second stage of the study adopted a within-participant behavioral design to examine how prosodic well-formedness influences perception. Each participant was exposed to stimuli that varied systematically in Prosodic Well-formedness (well-formed vs. violating) and Weight Class (light, heavy, superheavy). Stimuli were randomized, with inter-stimulus intervals of 800–1,000 ms, and each trial began with a fixation cross followed by the auditory token. Participants first completed speeded acceptability judgments to orient attention to form, then proceeded to an auditory lexical decision task to assess automaticity. During both tasks, keypress responses and reaction times (ms) were recorded.

To maintain data quality, trials affected by technical issues were flagged, and participants with more than 20 percent missed responses or less than 60 percent accuracy were excluded from the reaction-time analysis. This design ensured that results reflected genuine perceptual sensitivity to prosodic well-formedness rather than artifacts of inattentiveness or equipment error.

3.5. Data Analysis

Production analyses. Descriptive statistics summarize the proportion of tokens meeting bimoraicity or foot alignment. To test whether syllable weight predicts modification or prosodic satisfaction, we used chi-square tests of independence (with Bonferroni-adjusted residuals as needed). The manuscript reports a robust association between syllable weight and modification (χ^2 (2, N=538) =96.4, p<.001). Data were also inspected across age groups (20–30, 31–40, 41–50) to evaluate distributional stability.

Constraint modeling. We evaluated whether the ranking BIMORAICITY ≫ ALIGN-FT-L ≫ PARSE-

SYL accounts for the observed distributions by comparing predicted vs. observed frequencies across weight classes and morphological categories (goodness-of-fit and error patterns). The manuscript's results and hypotheses explicitly articulate this ranking as the working model.

Perception data were analyzed using mixed-effects modeling to assess how prosodic well-formedness and syllable weight influenced both judgment ratings and processing speed. For the acceptability task, ordinal mixed-effects (cumulative link) models predicted ratings based on Prosodic Well-formedness, Weight Class, and their interaction, with random intercepts for participants and items to account for individual and item-level variability. For the lexical decision task, reaction times from correct trials were trimmed (±2.5 SD within participant), log-transformed to normalize distributions, and analyzed through linear mixed-effects models using the same fixed-effect structure. Accuracy (coded 0/1) was further modeled using mixed-effects logistic regression.

These analyses directly tested whether well-formed reduplicants—those satisfying bimoraicity and stress alignment—elicited higher acceptability ratings, faster reaction times, and greater accuracy than prosodically violating forms. Demonstrating such differences would provide behavioral evidence that the hypothesized constraint hierarchy has measurable processing correlates, thereby linking formal prosodic structure to real-time cognitive performance.

Triangulation was achieved by integrating evidence from three complementary sources: (a) distributional patterns in the production data, (b) categorical judgments from acceptability ratings, and (c) response latencies from lexical decision tasks. Convergence across these strands—specifically, the dominance of bimoraicity in production and the processing advantage for bimoraic stimuli in perception—provides strong support for the claim that a single underlying constraint hierarchy governs both grammatical structure and cognitive processing in Saudi Arabic reduplication.

3.6 Ethical Considerations

All participants provided informed consent prior to participation. Data were anonymized at the point of collection, and any identifying information was stored separately from responses and audio recordings. Participation was voluntary, and participants could withdraw at any time without penalty. Study procedures complied with institutional and applicable national guidelines for research involving human participants, and ethics approval was obtained from the host university's review board (protocol number available on request). Stimuli were screened to avoid offensive or sensitive content, and participants were debriefed in clear, non-technical language.

Informed Consent Statement: Informed consent was obtained from all participants involved in the study.

Data Availability Statement: Due to participant privacy and the consent conditions for voice recordings, the raw audio data are not publicly available. Anonymized derived measures (e.g., syllable-weight and bimoraicity coding) and the analysis scripts are available from the corresponding author upon reasonable request.

3.7. Methodological Limitations

Three limitations merit acknowledgment. First, although the production dataset is sizable and diverse, corpus sources may overrepresent specific registers; elicitation helps but cannot fully equalize genre effects. Second, laboratory perception tasks (speeded judgments, lexical decision) are proxies for real-world processing; ecological validity is necessarily limited even as internal validity is strong. Third, the present design focuses on *weight* and *foot alignment*; other constraints (e.g., positional faithfulness, phonotactic neighborhood density) may modulate acceptability and RTs and warrant targeted follow-up work. We therefore interpret results as evidence for a *dominant* hierarchy—where bimoraicity leads—while remaining open to refinements as broader constraint sets and discourse conditions are tested in future research. (The manuscript's results already indicate bimoraicity's predominance and a smaller role for metrical alignment).

4. RESULTS

4.1. Overview And Research Questions

This section addresses the four research questions:

1. What prosodic constraints govern reduplication in Saudi Arabic, and how are they hierarchically ranked within an Optimality Theory (OT) framework?
2. How does syllable weight interact with these constraints?
3. How does Saudi Arabic compare typologically with other languages?
4. Do listeners demonstrate processing advantages for bimoraic, stress-aligned reduplicants?

Data from 538 corpus and elicited tokens and two

psycholinguistic tasks (speeded acceptability and lexical decision) are synthesized below to reveal how grammatical patterns align with real-time processing.

4.2. Quantitative Findings from Corpus and Production Data

4.2.1. Dominance Of Bimoraic Constraints.

Analysis of the production data confirms that bimoraicity is the dominant constraint in Saudi Arabic reduplication. Of all tokens, 437 (82.3%) satisfied bimoraic requirements, while 78 (14.7%) aligned primarily with metrical-foot structure and only 16 (3.0%) were nonconforming.

This pattern supports the hypothesis that moraic structure governs reduplicant formation more strongly than metrical alignment. Light syllables (CV) were most susceptible to modification, undergoing augmentation (via vowel lengthening or gemination) in 73.2% of cases. In contrast, heavy syllables (CVC, CVV) remained stable in 91.4%, and superheavy syllables (CVVC, CVCC) displayed mixed behavior (43.6%). The association between syllable weight and modification was statistically significant, $\chi^2(2, N = 538) = 96.4$, $p < .001$. These results demonstrate that reduplicants in Saudi Arabic maintain a minimum bimoraic size, confirming the weight-based conditioning predicted by OT.

Table 1: Distribution of Reduplicative Forms by Prosodic Conformity.

Prosodic Category	Count (N = 538)	Percentage (%)	Example Form
Bimoraic (μμ)	437	82.3	*fa.rħaː n fa.rħaː n*
Foot-aligned (metrical)	78	14.7	*sa.ri sa.ri*
Non-conforming	16	3.0	*lo.lo* (loanword)
Total	**538**	**100**	—

As Table 1 shows, reduplication in Saudi Arabic is overwhelmingly constrained by bimoraic structure, establishing a foundation for examining how these patterns vary across morphological and stylistic domains.

4.2.2. Morphological And Register Distributions.

Table 2 shows that partial reduplication (52.5%) slightly exceeds full reduplication (47.5%), with adjectives contributing the highest proportion of both types. Reduplication occurs most often in informal speech (≈64%), followed by narrative discourse (≈21%), reflecting its primary role in emphasis and expressivity rather than grammatical inflection. Across all examples, phonotactic constraints were consistently respected—gemination was preserved, codas were adjusted to maintain permissible syllable structures, and overall prosodic integrity was maintained. These regularities indicate that reduplication in Saudi Arabic is governed by prosodic constraints rather than morphological or lexical exceptions, and that it functions most prominently in adjectives and informal speech as a prosodically constrained yet pragmatically expressive feature of the language

Table 2: Distribution of Reduplication by Morphological Category and Register.

Morphological Category	Full Reduplication n (%)	Partial Reduplication n (%)	Total n (%)	Dominant Register (%)
Adjectives (e.g., *ħilw ħilw*)	112 (47.3)	124 (52.7)	236 (44.4)	Informal (68)
Nouns (e.g., *bēt bēt*)	53 (49.1)	55 (50.9)	108 (20.3)	Narrative (61)
Verbs (e.g., *ʔaʕṭa ʔaʕṭa*)	41 (43.6)	53 (56.4)	94 (17.7)	Informal (64)
Expressions (e.g., *baʕīd baʕīd*)	46 (46.0)	54 (54.0)	100 (18.8)	Informal (63)
Total	252 (47.5)	286 (52.5)	**538 (100)**	—

4.2.3. Age And Variation.

Although age-based differences were small, older speakers (41–50 years) showed adherence rates to bimoraic patterns comparable to younger speakers (20–30 years) (≈25% vs. ≈27%). Overall, the similarity across generations suggests these prosodic preferences are stable properties of Saudi Arabic phonology rather than recent innovations.

4.2.4. Deviations And Exceptions.

Only 3% of the dataset displayed nonconforming reduplication, primarily involving loanwords (68.8%), specialized vocabulary (18.8%), and idioms (12.5%). These exceptions confirm that violations are contextually motivated and peripheral to the system, strengthening the claim that bimoraicity outranks other constraints in Saudi Arabic grammar.

4.3. Qualitative Patterns and Thematic Observations

4.3.1. Interaction Between Syllable Weight and Augmentation.

Qualitative inspection shows that light syllables frequently undergo compensatory augmentation to satisfy moraic weight. For instance, */fa.raħ/ → /fa.rħaːn fa.rħaːn/* demonstrates vowel lengthening, and */sa.ri/ → /saːri: saːri:/* exhibits moraic reinforcement through vowel extension. These modifications are not random: speakers consistently apply them to achieve rhythmic balance, indicating an internalized constraint ranking where *BIMORAICITY ≫ ALIGN-FT-L ≫ PARSE-SYL*. Such qualitative evidence bridges distributional statistics and the perceptual prominence of well-formed reduplicants.

4.3.2. Dialectal And Cross-Linguistic Positioning.

Comparative data show that Saudi Arabic aligns typologically with Semitic systems exhibiting strong weight sensitivity, such as Modern Standard Arabic and Egyptian Arabic, but diverges from Austronesian and Bantu languages that tolerate CV reduplication. In Tagalog, for instance, reduplication often takes the CV form */su-sulat/*, violating bimoraicity, while Saudi Arabic strictly enforces bimoraic templates.

Similarly, Bantu languages like Swahili allow variable reduplicant size, while Saudi Arabic restricts reduplication to weight-balanced adjectives and expressive forms. These contrasts underscore Saudi Arabic's typological rigidity and its role as a prosodically conservative dialect within the Semitic family.

4.3.3. Functional Distribution and Expressive Emphasis.

Lexical analysis reveals that reduplication in Saudi Arabic serves primarily semantic and pragmatic intensification, not grammatical inflection. For example, */ħilw ħilw/* 'very nice' and */baʕiːd baʕiːd/* 'far away' highlight expressive emphasis rather than morphological derivation. Speakers employ reduplication to reinforce affect, contrast, or exaggeration, mirroring universal functions observed in expressive morphology.

These findings explain why adjectives dominate reduplicative constructions—prosodic constraints interact with discourse-driven emphasis, producing forms that are both phonologically balanced and communicatively salient.

4.4. Psycholinguistic Findings from Perception Study

4.4.1. Acceptability Judgments.

Preliminary analysis of the speeded acceptability task revealed a consistent bias toward bimoraic and stress-aligned forms. Conforming reduplicants were rated significantly higher (M = 3.82, SD = 0.47) than violating ones (M = 2.45, SD = 0.61), β = 1.32, SE = 0.23, z = 5.71, p < .001. Within conforming items, aligned forms gained an additional advantage (β = 0.58, SE = 0.19, p < .01). These results support the hypothesis that listeners are perceptually sensitive to prosodic well-formedness.

4.4.2. Lexical Decision Accuracy and Speed.

In the auditory lexical decision task, accuracy was higher for conforming reduplicants (M = 91.8%) than for violating forms (M = 78.5%), OR = 3.21, 95% CI [2.01, 5.12], p < .001. Reaction times followed the same pattern: responses were faster for well-formed reduplicants (M = 742 ms, SD = 118) than for violations (M = 823 ms, SD = 134), t(47) = 5.03, p < .001.

A significant Weight × Bimoraicity interaction (β = −0.41, SE = 0.14, p = .003) indicated that violations involving light syllables incurred the greatest processing cost—precisely those most prone to augmentation in production data. This convergence between perception and production confirms the cognitive reality of the constraint hierarchy established in Study 1.

Table 3: Summary of Perception Results: Acceptability Ratings, Accuracy, and Reaction Times.

Measure	Condition	Mean (M)	SD	Test / Model	*p*-value	Interpretation
Acceptability (4-point scale)	Well-formed (bimoraic + aligned)	3.82	0.47	β = 1.32 (SE = 0.23, *z* = 5.71)	< .001	Higher ratings for prosodically well-formed items
	Violating	2.45	0.61	—	—	—
Lexical Decision – Accuracy (%)	Well-formed	91.8	5.2	OR = 3.21 [2.01, 5.12]	< .001	Greater accuracy for well-formed reduplicants
	Violating	78.5	7.4	—	—	—
Lexical Decision – RT (ms)	Well-formed	742	118	*t*(47) = 5.03	< .001	Faster responses for well-formed stimuli
	Violating	823	134	—	—	—

As Table 3 indicates, listeners exhibit a strong perceptual bias toward bimoraic, stress-aligned reduplicants, confirming that prosodic well-formedness facilitates both recognition accuracy and

processing speed.

Table 4: Mixed-Effects Model Summaries for Perception Tasks.

Model	Predictor	Estimate (β)	SE	*z* / *t*	*p*	Interpretation
Acceptability (ordinal mixed-effects)	(Intercept)	0.74	0.15	4.91	< .001	Baseline acceptability level
	Prosodic Well-formedness	1.32	0.23	5.71	< .001	Higher ratings for well-formed stimuli
	Weight Class	0.48	0.18	2.67	.008	Heavier syllables rated higher
	Well-formedness × Weight	−0.41	0.14	−2.93	.003	Violations in light syllables most penalized
Lexical Decision (Accuracy, logistic)	(Intercept)	2.46	0.31	7.94	< .001	Baseline log-odds of correct response
	Prosodic Well-formedness	1.17	0.26	4.48	< .001	Greater accuracy for well-formed items
	Weight Class	0.39	0.19	2.05	.041	Moderate effect of syllable weight
	Well-formedness × Weight	−0.33	0.13	−2.54	.011	Interaction: strongest penalty for light-syllable violations
Lexical Decision (RT, linear mixed-effects)	(Intercept)	7.02	0.05	140.4	< .001	Mean log RT (ms) baseline
	Prosodic Well-formedness	−0.09	0.02	−4.50	< .001	Faster responses for well-formed stimuli
	Weight Class	−0.04	0.02	−2.00	.047	Slightly shorter RTs for heavier syllables
	Well-formedness × Weight	0.05	0.02	2.31	.021	RT cost for light-syllable violations

4.5. Integration Of Quantitative and Qualitative Strands

When considered together, the findings demonstrate a clear convergence between the formal grammar and cognitive processing of Saudi Arabic reduplication. Production data reveal categorical adherence to bimoraicity, showing that speakers consistently generate reduplicants that meet minimal moraic weight requirements. Perceptual data, in turn, indicate graded sensitivity to the same constraint hierarchy, as listeners respond more quickly and accurately to bimoraic, stress-aligned forms than to prosodically ill-formed ones. Complementing these results, qualitative observations show that speakers employ augmentation and rhythmic adjustments not only to satisfy prosodic balance but also to enhance communicative emphasis. Collectively, these strands of evidence converge on the conclusion that Saudi Arabic reduplication reflects a unified system in which grammatical structure, rhythmic regularity, and perceptual processing reinforce one another.

Minor divergences—such as the few loanword violations—reflect lexical borrowing rather than prosodic instability. Thus, both strands align with the hypothesis that BIMORAICITY outranks ALIGN-FT-L, which in turn outranks PARSE-SYL in the Saudi Arabic grammar.

4.6. Interpretive Summary

The results collectively support all four research questions. Reduplication in Saudi Arabic is fundamentally weight-driven, with bimoraic minimality serving as the organizing principle. Syllable weight determines whether augmentation occurs, while metrical-foot alignment fine-tunes stress distribution. Cross-linguistically, Saudi Arabic aligns with other Semitic languages but enforces stricter prosodic conformity than Egyptian, Levantine, or Maghrebi varieties.

Psycholinguistic evidence substantiates the cognitive grounding of these constraints: listeners process bimoraic, stress-aligned reduplicants more efficiently than ill-formed ones, demonstrating that the constraint hierarchy is not merely formal but psychologically real.

Together, these findings extend Optimality Theory by linking abstract constraint rankings to measurable perceptual outcomes, thereby bridging the divide between grammatical representation and language processing. Saudi Arabic thus emerges as a prosodically conservative yet cognitively efficient system, reinforcing the broader claim that prosodic morphology reflects both structural economy and perceptual optimization.

5. DISCUSSION

5.1. Overview And Theoretical Framing

This study set out to examine the prosodic constraints that shape reduplication in Saudi Arabic and to test whether these constraints have cognitive correlates in perception. Using an Optimality Theory (OT) framework, it proposed that *BIMORAICITY*—the requirement that prosodic constituents be minimally two moras—outranks *ALIGN-FT-L* (alignment with metrical feet) and *PARSE-SYL*

(syllable parsing). The findings from both production and perception converge on a single conclusion: Saudi Arabic reduplication is governed primarily by weight-based constraints, revealing a system where prosodic structure is tightly bound to rhythmic and cognitive organization.

The theoretical significance lies in demonstrating that constraint hierarchies, as postulated by OT, are not only formal abstractions but also psychologically real. Speakers not only produce forms that conform to bimoraic minimality but also process them more efficiently. This alignment between grammar and cognition reinforces the OT premise that linguistic competence reflects a ranking of violable constraints optimized for communicative efficiency and perceptual salience (Prince & Smolensky, 2004).

5.2. Alignment And Divergence with Previous Studies

5.2.1. Confirming Cross-Linguistic Trends.

The dominance of bimoraic constraints in Saudi Arabic aligns with extensive cross-linguistic evidence from both Semitic and non-Semitic languages. Similar results have been reported for Cairene and Jordanian Arabic (Broselow, 1992; Davis & Zawaydeh, 2001), Tagalog (Frampton, 2009), and Bantu (Downing, 2006), where reduplicants conform to a minimal word size equivalent to a bimoraic foot. The present data strengthen this generalization by showing that even within a dialectal context, the bimoraic requirement remains robust, suggesting that moraic structure is a universal organizing principle of reduplication.

However, Saudi Arabic differs in its stringency: unlike Egyptian or Levantine Arabic, it shows minimal tolerance for sub-minimal reduplicants. For example, in Egyptian Arabic, CV reduplication (e.g., *ki-ki* for emphasis) can occasionally surface in expressive speech, whereas in Saudi Arabic, such forms are nearly absent from the corpus. This rigidity suggests that the dialect preserves a conservative prosodic system, possibly influenced by Classical Arabic's preference for moraic uniformity (Kiparsky, 2003). The finding situates Saudi Arabic toward the typologically "strict" end of the prosodic spectrum, sharing features with templatic Semitic systems like Hebrew and Maltese, which also enforce bimoraic minimality.

5.2.2. Divergence From Metrical-Dominant Systems.

In languages where metrical-foot alignment outranks bimoraicity—such as Fijian or certain Austronesian varieties (Yu, 2007; Alderete et al., 1999)—reduplicants are shaped primarily by stress patterning rather than syllable weight. Saudi Arabic, by contrast, gives clear precedence to weight over metrical alignment. The secondary role of *ALIGN-FT-L* (14.7% of cases) indicates that stress serves a fine-tuning function, adjusting prosodic balance once moraic requirements are satisfied.

This contrast suggests a gradient typology of constraint interaction: whereas metrical languages prioritize rhythmic regularity, weight-sensitive languages like Saudi Arabic prioritize structural stability. This finding contributes to a nuanced understanding of how constraint hierarchies can be typologically parameterized without abandoning OT's universalist foundation.

5.3. Cognitive And Psycholinguistic Corroboration

The perception experiment provides independent evidence that prosodic constraints shape real-time processing. Listeners judged bimoraic, stress-aligned reduplicants to be more acceptable and responded to them more quickly than to ill-formed counterparts. This pattern aligns with Hayes and Wilson's (2008) finding that phonotactic well-formedness predicts processing ease, supporting the view that constraint satisfaction has measurable perceptual correlates.

The experiment included reduplicated Saudi Arabic forms and phonotactically matched non-reduplicated controls. Stimuli were constructed to be comparable in segmental composition and length, and were balanced across the prosodic contrasts central to the analysis, including syllable-weight profiles and reduplicant shape. All items were screened for naturalness and presented in randomized order.

The Weight × Well-formedness interaction is particularly informative. Configurations involving light syllables imposed a greater processing cost—the same configurations that trigger augmentation in production. This parallel between production repair and perceptual penalty suggests that the prosodic grammar is not merely descriptive: it tracks structures that are dispreferred both in speech and in comprehension. The convergence strengthens the cognitive plausibility of OT and speaks to a long-standing concern that constraint hierarchies lack direct psycholinguistic grounding (Moreton & Pater, 2012).

More broadly, the findings are compatible with emergentist accounts that link morphophonological patterning to perceptual optimization. In this view, reduplication is not only a morphological device but

also a prosodic strategy that promotes rhythmic stability and processing efficiency—what Gordon (2016) characterizes as "metrical harmony." Saudi Arabic's preference for bimoraic templates thus reflects both formal economy and perceptual efficiency.

5.4. Unexpected Outcomes and Interpretive Insights

A minor but intriguing finding concerns the 3% of nonconforming reduplicants, most of which involve loanwords and idiomatic expressions. Rather than challenging the overall hierarchy, these exceptions illuminate how external factors—lexical borrowing and sociolinguistic variation—interact with prosodic systems. Loanwords often enter the language with phonotactic profiles that resist native constraint conformity, and speakers may reproduce these forms faithfully to preserve their social or stylistic authenticity (Haugen, 1950).

Another observation is the stability across generations. Despite expectations of potential change driven by media exposure or dialect contact, older and younger speakers displayed comparable adherence to bimoraic constraints. This continuity may indicate that prosodic architecture, unlike lexis or syntax, is relatively resistant to sociolinguistic drift. It also suggests that Saudi Arabic's rhythmic system is deeply entrenched in phonological competence, not easily reshaped by external influence.

Finally, the perceptual advantage for stress-aligned reduplicants—though secondary to moraic effects—points to a subtle interplay between weight and rhythm. Stress alignment does not override bimoraicity but enhances processing fluency once minimal weight is satisfied. This hierarchy mirrors natural prosodic layering: moraic balance establishes structural integrity, while stress ensures rhythmic prominence.

5.5. Pedagogical And Applied Implications

While the study's theoretical orientation is primarily phonological, its findings have indirect pedagogical and computational implications. In Arabic language instruction, understanding prosodic constraints can inform pronunciation and morphology teaching, particularly in differentiating templatic structures across dialects. Learners of Arabic often struggle with reduplication and vowel length distinctions; insights into moraic weighting could aid in developing targeted pronunciation exercises emphasizing rhythmic timing.

In speech technology, the results hold value for natural language processing (NLP) and text-to-speech (TTS) systems. Computational models of Arabic speech synthesis often falter in generating dialect-specific prosody. Incorporating constraint hierarchies such as *BIMORAICITY* ≫ *ALIGN-FT-L* into computational grammars could enhance the naturalness of synthetic speech, ensuring that reduplicated or expressive forms conform to authentic prosodic templates.

Moreover, the study underscores the importance of integrating phonological theory with psycholinguistic evidence in applied research domains. Bridging these disciplines supports the development of technologies that not only simulate linguistic patterns but also mirror human perceptual processing.

5.6. Limitations And Future Research

Although the current study provides robust quantitative and experimental evidence, several limitations warrant acknowledgment. First, the corpus data, while diverse, primarily represent educated speakers from central Saudi Arabia. Broader sampling—including regional varieties such as Hijazi, Najrani, and Eastern dialects—could reveal micro-differences in prosodic ranking. Second, the perception experiment, though well-controlled, tested only auditory processing. Future studies might integrate neurocognitive measures (e.g., EEG or eye-tracking) to capture real-time processing of prosodic violations.

Third, while the OT analysis effectively models constraint interaction, it simplifies the broader phonological environment by focusing on three primary constraints. Future work should test whether additional factors—such as positional faithfulness, prosodic phrasing, or tonal alignment—interact with the current hierarchy. Cross-dialectal modeling using stochastic OT or Harmonic Grammar could also quantify variation rather than treat it as categorical.

Finally, while bimoraicity appears to dominate Saudi Arabic reduplication, other morphological phenomena—like truncation, infixation, and reduplication in loan adaptations—may reveal alternative rankings. Exploring these processes would help determine whether constraint hierarchies are phenomenon-specific or globally consistent across the language's grammar.

5.7. Integrative Reflection

Taken together, the findings reaffirm the central claim that prosodic morphology is a bridge between structure and cognition. The Saudi Arabic data

illustrate a self-reinforcing system: grammatical constraints favor weight-balanced forms, and listeners exhibit perceptual preferences that sustain those same forms. This synergy between production and perception embodies the principle of constraint convergence, wherein linguistic systems evolve toward forms that are both structurally optimal and cognitively efficient.

At a theoretical level, the study refines Optimality Theory by grounding its constraint rankings in experimental data, supporting the view that phonological well-formedness is not merely symbolic but perceptually motivated. At an applied level, it invites interdisciplinary dialogue between formal linguistics, psycholinguistics, and computational modeling.

Saudi Arabic thus emerges not simply as a descriptive case but as a theoretical proving ground for prosodic morphology—demonstrating how constraint hierarchies manifest in real usage, endure across generations, and align with human processing mechanisms. This alignment between grammar, cognition, and typology advances our understanding of how prosodic systems maintain both universality and variation, fulfilling the broader goal of integrating linguistic theory with empirical evidence.

6. CONCLUSION

This study examined the prosodic constraints governing reduplication in Saudi Arabic, integrating corpus, elicited, and psycholinguistic data to test whether prosodic structure reflects both grammatical hierarchy and cognitive processing. Within the framework of Optimality Theory, it proposed and empirically supported a constraint ranking—BIMORAICITY ≫ ALIGN-FT-L ≫ PARSE-SYL—demonstrating that bimoraicity dominates the organization of reduplicative forms in both production and perception. The results reveal that Saudi Arabic operates as a prosodically conservative system, favoring weight-balanced and rhythmically coherent forms that sustain cognitive ease and phonological stability.

The findings confirm that prosodic morphology is not purely formal but functionally grounded. The dominance of bimoraic constraints in production and the perceptual preference for well-formed reduplicants indicate that speakers and listeners share a unified prosodic grammar. This convergence between linguistic structure and cognitive performance reinforces the theoretical premise of Optimality Theory: languages optimize competing constraints to achieve forms that are simultaneously efficient, learnable, and perceptually salient. In Saudi Arabic, the bimoraic minimal word functions as a cognitive and rhythmic anchor, guiding both how reduplication is realized and how it is processed.

By situating Saudi Arabic within the broader typology of prosodic systems, the study contributes to refining our understanding of cross-linguistic constraint hierarchies. It demonstrates that even within the Semitic family—characterized by templatic morphology—individual dialects exhibit distinctive constraint rankings reflecting their phonological histories and rhythmic preferences. Saudi Arabic's near-absolute conformity to bimoraicity distinguishes it from dialects that tolerate lighter or truncated reduplicants, suggesting that prosodic conservatism may be a hallmark of its linguistic identity. This typological insight underscores the flexibility of the OT framework: constraint sets remain universal, but their rankings are locally adaptive.

Beyond theory, the study carries implications for pedagogy and language technology. For language teachers and learners, understanding moraic structure provides a practical lens for mastering rhythm, stress, and reduplication in Arabic. Instruction that explicitly highlights syllable weight and bimoraic timing could enhance pronunciation accuracy and fluency, particularly for non-native learners unfamiliar with quantity-based prosody. For curriculum designers, integrating prosodic awareness into phonology modules can help bridge the gap between abstract phonological knowledge and its auditory realization.

In computational linguistics, these findings inform speech synthesis and recognition systems. Incorporating weight-based constraints into computational grammars can improve the naturalness of generated Arabic speech, especially for expressive or reduplicative forms. Prosody-sensitive modeling grounded in empirical constraint hierarchies may also enhance dialect-specific TTS systems, ensuring that digital outputs mirror authentic rhythm and moraic timing. The study thus illustrates how theoretical phonology can contribute to real-world applications in educational technology and natural language processing.

Nevertheless, the research is not without limitations. The dataset, while extensive, is confined primarily to central Saudi dialects; including additional regional varieties would clarify whether bimoraicity is a nationwide feature or regionally variable. The perception experiments, though methodologically sound, relied on behavioral measures rather than neurophysiological data. Future studies employing EEG or eye-tracking could

provide finer-grained evidence for the temporal dynamics of constraint satisfaction. Additionally, extending this framework to other morphological phenomena—such as truncation, infixation, or compounding—could determine whether the observed hierarchy generalizes beyond reduplication.

Future research should also explore social and stylistic dimensions of prosodic variation. Since reduplication often indexes expressivity and emphasis, investigating its use in media, poetry, and youth speech could reveal how prosodic rules interact with discourse and identity. Combining experimental phonology with corpus sociolinguistics would enable a fuller account of how constraint hierarchies evolve under communicative and cultural pressures.

Ultimately, this study reaffirms that prosodic structure is both a grammatical system and a cognitive rhythm. Saudi Arabic exemplifies how languages preserve phonological balance through constraint optimization—ensuring that what sounds natural is also what the grammar prefers. By bridging the gap between formal theory and perceptual evidence, the research advances our understanding of how linguistic systems achieve equilibrium between structure, function, and cognition.

In a broader sense, the study advocates for a cognitively grounded prosodic morphology—one that unites the elegance of formal models with the reality of human processing. As languages evolve, this balance between rhythmic precision and communicative efficiency will continue to define not only the sound of speech but the architecture of linguistic thought itself.

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