



Constraint Transfer and Reranking in L3 English Vowel Acquisition: An Optimality-Theoretic Account of Moroccan Multilingual Speech

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Abstract

This theoretical article models the acquisition of English high-vowel contrasts by Moroccan multilingual learners through an Optimality-Theoretic account of transfer and cue development. The focus is the contrast between /i:-ɪ/ and /u:-ʊ/, a learning problem because Tashlhiyt, Moroccan Arabic, and French all provide peripheral high vowels but no four-member high-vowel system equivalent to English. The study uses a comparative phonological analysis of the target and source systems, formulates a restricted set of markedness and faithfulness constraints, and derives ranking hypotheses that can be tested in future perception and production research. The proposed baseline grammar ranks *HI-LAX and *V: above IDENT-IO(TENSE) and MAX-μ, predicting merger of /i:-ɪ/ to [i] and /u:-ʊ/ to [u]. Independent promotion of MAX-μ and IDENT-IO(TENSE) yields duration-first and quality-first intermediate grammars. The analysis links these rankings to major L3 transfer models and argues for a property-by-property account in which vowel quality and duration may develop asynchronously.

1. Introduction

English high-vowel contrasts present a compact but revealing problem for learners whose prior languages do not separate tense and lax high vowels in the same way as English. The contrast between /i:/ and /ɪ/, and between /u:/ and /ʊ/, is not only a matter of long versus short vowels. In descriptions of Standard Southern British English and General British English, the members of each pair differ in spectral quality, duration, lexical distribution, and, in the case of contemporary /u:/, sometimes in the degree of fronting or internal movement (Deterding, 1997; Cruttenden, 2014). The traditional labels tense and lax are therefore useful shorthand, but they should not be read as simple articulatory measurements of muscular tension or as duration alone (Durand, 2005). A learner may preserve one cue while neutralising another; for instance, a long [i:] and a short [ɪ] can preserve timing without establishing the full quality opposition associated with sheep and ship.

The Moroccan multilingual context makes this learning problem especially interesting. Many university learners of English have developed linguistic repertoires that include Tashlhiyt or another Amazigh variety, Moroccan Arabic, Modern Standard Arabic, French, and English, but the sequence and dominance of these languages vary across speakers. Some learners are Tashlhiyt-dominant in the home, use Moroccan Arabic in wider communication, encounter Standard Arabic through schooling, and develop substantial French before or alongside English. Others are Darija-dominant and have weaker Amazigh competence. For this reason, the labels L1, L2, and L3 cannot be applied uniformly to all Moroccan speakers without

documenting individual profiles (Ennaji, 2005). A simple comparison between English and one first language would therefore miss the multilingual nature of the learner's phonological system.

The structural issue, however, is clear. Tashlhiyt, Moroccan Arabic, and French all provide high peripheral vowels that may support English [i] and [u]-like targets, yet none provides a four-member high-vowel inventory equivalent to English /i:/, ɪ, u:/, ʊ/. Tashlhiyt is commonly analysed with the lexical vowels /i, a, u/, while schwa-like intervals are better treated with attention to phonetic transition, syllable structure, and prosodic conditioning rather than as straightforward lexical vowels (Ridouane, 2008, 2014; Ridouane & Cooper-Leavitt, 2019). Moroccan Arabic is also frequently described around peripheral /i, a, u/ and a central vowel whose representation and distribution have generated substantial analysis (Harrell, 1962; Heath, 1987; Bensoukas & Boudlal, 2012). French supplies stable /i/ and /u/, but it does not lexicalise English-like /ɪ/ and /ʊ/ or a comparable high-vowel length opposition (Fougeron & Smith, 1993).

This shared gap creates a theoretical question: how can a learner construct four English high-vowel categories from a multilingual repertoire that strongly supports [i] and [u] but does not directly support English /ɪ/ and /ʊ/? The question is not simply pedagogical. It concerns the organisation of phonological transfer in multilingual acquisition. Research on third-language phonology has increasingly emphasised that the source of influence may differ across domains and properties rather than being copied wholesale from one previous language (Cabrelli Amaro & Wrembel, 2016; Wang & Nance, 2023). Evidence from North African L3 English also supports a property-by-property interpretation, with segmental and prosodic patterns drawing on different sources in Arabic-French-English repertoires (Archibald, 2022).

Optimality Theory (OT) offers a useful formal language for this problem because it represents phonological grammars as rankings of violable markedness and faithfulness constraints (Prince & Smolensky, 2004). A prior Moroccan study by Zouiten (2020) demonstrates the usefulness of OT for modelling the acquisition of English diphthongs by EFL learners, but it does not address the high-vowel tense-lax contrasts examined here or the interaction of multiple potential source languages. OT does not decide by itself which previous language is active. That issue belongs to theories of cross-linguistic influence and third-language acquisition. What OT can do is state the output consequences of a ranking and show how partial reranking may produce intermediate grammars. The present article therefore develops a restricted OT model of English high-vowel acquisition in Moroccan multilingual phonology. It does not report new learner data. Instead, it formulates a falsifiable hypothesis space for future perception and production research. The analysis asks three questions: what outputs follow if source-compatible markedness outranks faithfulness to English high-vowel quality and duration; what intermediate systems arise if quality and duration develop separately; and how can these rankings be interpreted under competing models of multilingual transfer?

This framing is intended to make the article suitable for a journal whose readership includes linguistics, language teaching, and TESL scholars. The article keeps the formal OT machinery visible, but it also translates each ranking into observable outcomes for future studies. In this way, the formal analysis is not presented as an abstract exercise only; it is used to clarify why Moroccan multilingual learners may show different paths toward the same English contrast.

2. Literature Review

2.1 English high vowels as a learning target

The English high-vowel pairs /i:-ɪ/ and /u:-ʊ/ are useful for second and third language phonology because they require learners to coordinate more than one cue. In British English descriptions, /i:/ is typically longer and more peripheral than /ɪ/, while /u:/ and /ʊ/ differ in quality, duration, and distribution. Contemporary fronting of /u:/ in many British varieties adds another difficulty: learners cannot simply equate English /u:/ with a maximally back cardinal

[u:] (Cruttenden, 2014). The target is therefore a contrastive relation, not a single isolated sound. To acquire the system, learners must treat quality and duration as jointly relevant while also learning the lexical distribution of each vowel.

Second-language speech research has repeatedly shown that unfamiliar vowel contrasts are difficult when the learner assimilates two target categories to one existing category or when the learner gives insufficient weight to a cue that is not contrastive in the prior language. The Speech Learning Model and related approaches emphasise the role of perceived phonetic distance and category equivalence in L2 speech learning (Flege, 1995). The Perceptual Assimilation Model for L2 speech learning similarly predicts difficulty when two target sounds are assimilated to one native category or when the contrast is poorly discriminated (Best & Tyler, 2007). The Second Language Linguistic Perception model adds that learners must build language-specific mappings between acoustic cues and phonological categories (Escudero, 2005). Although the present article is formal rather than experimental, these perspectives justify treating English high-vowel acquisition as a problem of category construction and cue weighting rather than as a simple matter of imitation.

2.2 Moroccan multilingual high-vowel resources

The relevant Moroccan multilingual repertoire provides facilitation and difficulty at the same time. Tashlhiyt is theoretically well known because of its small vowel inventory and unusual syllabic possibilities. Dell and Elmedlaoui's foundational analyses of syllabic consonants and syllabification in Tashlhiyt (1985, 2002), later developed through phonetic and phonological studies by Ridouane, show that the language cannot be understood through a simple vowel-centred syllable model. For the specific question addressed here, the most important point is not the full complexity of Tashlhiyt syllabification but the absence of a lexical four-way high-vowel contrast corresponding to English /i:/, ɪ, u:/, ʊ/ (Ridouane, 2008, 2014).

Moroccan Arabic also lacks a matching system. Its vowel inventory and schwa patterns have been analysed in different ways, especially in relation to syllable structure and vowel-zero alternations. Descriptions generally recognise peripheral high vowels that can support [i] and [u]-like outputs, but they do not provide direct lexical equivalents of English high lax vowels (Harrell, 1962; Heath, 1987; Bensoukas & Boudlal, 2012). French is different because it has a larger oral-vowel inventory and stable peripheral high vowels, including /i/ and /u/. Nevertheless, French does not provide English-like /ɪ/ and /ʊ/, and duration is not organised as the same high-vowel lexical contrast (Fougeron & Smith, 1993).

Recent Moroccan-oriented work strengthens the need for a multilingual account. Kula and Louriz (2024) show that Tashlhit speakers learning English mid and low vowels in a multilingual context may produce composite vowel categories rather than simple transfers from one source system. Their findings can generalise to the present analysis at the level of multilingual category formation, but they do not imply that high vowels will reproduce the same acoustic pattern. High vowels present a different structural configuration because Tashlhiyt, Moroccan Arabic, and French all provide strong peripheral /i/ and /u/ anchors, whereas English /ɪ/ and /ʊ/ occupy less peripheral regions and lack direct equivalents in those systems. This shared anchoring may facilitate the tense vowels /i:/ and /u:/ while encouraging the lax vowels to be assimilated toward [i] and [u], producing a more asymmetrical pattern than may arise for mid and low vowels. The inventory density and source-to-target relations are therefore different across the two vowel regions. Kula and Louriz's results support the possibility of composite multilingual categories, but the direction and degree of high-vowel compression must be tested independently. A model of English high vowels should consequently permit partial facilitation, persistent gaps, and property-specific development rather than assuming direct transfer from a single source system.

System	Relevant categories	Direct equivalent of /ɪ, ʊ/?	Analytical role
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English target	/i:, ɪ, u:, ʊ/	Not applicable	Target grammar with quality and duration contrasts
Tashlhiyt	/i, a, u/ with schwa-like intervals treated carefully	No	Possible source ranking supporting peripheral /i, u/
Moroccan Arabic	Peripheral /i, a, u/; central-vowel status varies by analysis	No direct pair	Possible dominant-language source supporting peripheral /i, u/
French	/i, y, u/ among a larger oral-vowel inventory	No	Possible L2/non-native source supporting peripheral /i, u/ quality

Table 1. High-vowel resources relevant to the proposed analysis.

2.3 Third-language phonological transfer models

Models of third-language acquisition provide different accounts of source selection. The L2 Status Factor predicts that a previously learned non-native language may receive privileged activation when a further non-native language is acquired or used (Williams & Hammarberg, 1998; Bardel & Falk, 2012). In many Moroccan educational histories, this makes French a plausible source of influence in English, especially for learners who have received sustained schooling through French. The Cumulative Enhancement Model proposes that all previously acquired languages remain available and that transfer is facilitative when a prior language supplies a compatible structure (Flynn, Foley, & Vinnitskaya, 2004). For English high vowels, this model predicts shared facilitation for peripheral [i] and [u], but it does not by itself predict the emergence of /ɪ/ and /ʊ/ when no prior system supplies equivalent categories.

Early empirical work illustrates why both language status and structural proximity must be considered. Llama, Cardoso, and Collins (2010) found that the phonological influence observed in an additional language can reflect an interaction between the status of a previously learned language and its distance from the target. Wrembel (2010) likewise documented L2-accented patterns in L3 production, showing that a non-native language may become an important source of phonetic influence. These studies make French a plausible source in Moroccan L3 English, but they do not justify treating it as automatic or exclusive; dominance, proficiency, typological relations, and the particular phonological property under study remain relevant.

More recent work in L3 phonology has moved the discussion beyond the simple question of whether the L1 or the L2 transfers. Wang and Nance (2023) argue that L3 phonological acquisition remains under-researched relative to other domains and that future models need to adapt L2 speech-learning frameworks such as SLM/SLM-r, PAM/PAM-L2, and L2LP to multilingual learning. Wrembel's (2023) state-of-the-art chapter makes a similar point: L3 phonological research must attend to production and perception together, to learner diversity, and to the methodological problem of comparing studies that differ in design, target structures, proficiency, and multilingual experience. These recent reviews justify the present article's attempt to connect a formal OT account to current multilingual speech-learning debates rather than treating OT as an isolated descriptive tool.

Empirical studies also support a feature-sensitive view of phonological cross-linguistic influence (CLI). Wrembel, Marecka, and Kopečková (2019) extend the Perceptual Assimilation Model to L3 phonological acquisition and show why multilingual perception cannot be reduced to a one-source transfer pathway. Wrembel, Gut, Kopečková, and Balas (2020) further show that multilingual phonological spaces can be reshaped early in learning, with category boundaries expanding to accommodate L1, L2, and L3 categories of similar phonetic type. Kopečková, Gut, Wrembel, and Balas (2023) find that L3 phonological CLI may vary feature by feature and that high inter- and intra-individual variation is not fully captured by existing transfer models. Their findings are especially important for the present analysis because the English high-vowel problem also separates several properties: place, tense-lax quality, duration, and cue integration.

This feature-sensitive orientation is compatible with the Linguistic Proximity Model, which permits influence to operate property by property, depending on which previous language is closest for the specific feature under acquisition (Westergaard, Mitrofanova, Mykhaylyk, & Rodina, 2017). It is also compatible with task-based findings in L3 phonetics. Patience and Qian (2022), for example, show that task complexity can affect the source and visibility of transfer because speakers may rely more strongly on dominant articulatory routines under heavier processing demands. For Moroccan learners, this means that a word-reading task, a sentence-reading task, and spontaneous production may not reveal exactly the same ranking. The present article therefore separates two questions: which prior language or combination of languages supports a particular property, and what output a selected or composite ranking produces under a given task condition.

2.4 Optimality Theory and additional-language phonology

In classical OT, GEN produces possible outputs for an input, CON supplies a universal set of constraints, and EVAL selects the candidate that best satisfies a language-specific ranking (Kager, 1999; Prince & Smolensky, 2004). Constraints are violable: a winning candidate may violate lower-ranked constraints if competing candidates violate higher-ranked ones. Correspondence Theory formalises input-output faithfulness relations and allows the analysis to state precisely which properties are preserved or changed (McCarthy & Prince, 1995). For additional-language phonology, this architecture is useful because learner outputs often reflect neither a perfect copy of the source language nor a fully target-like grammar. They may reflect transferred rankings, markedness effects, lexical knowledge, task demands, and gradual reranking under target input.

The model also needs to be brought into conversation with recent speech-learning theory. The revised Speech Learning Model proposes that L1 and L2 phonetic categories continue to interact dynamically and that category formation depends on perceived phonetic distance as well as the quantity and quality of input (Flege & Bohn, 2021). This is relevant to OT because reranking is not treated here as an abstract symbolic change disconnected from experience. Rather, a learner's increasing exposure to English can make target faithfulness constraints more active when the learner begins to perceive and produce stable differences between two categories that were previously assimilated to one source category. In this sense, OT gives a formal representation of the outcome, while speech-learning models explain why the learner may become sensitive to the acoustic and articulatory cues that support that outcome.

Broselow, Chen, and Wang (1998) famously showed how the emergence of unmarked structures in second-language phonology can be modelled when markedness dominates target faithfulness. Tesar and Smolensky (2000) link learning to changes in domination relations. The present article uses categorical, parallel OT for a narrower purpose: to derive the possible outputs of a high-vowel transfer schema. It does not claim to model token-by-token variation, gradient formant overlap, perceptual uncertainty, or the exact psycholinguistic process by which learners first construct English inputs. More variable approaches, including stochastic OT, Harmonic Grammar, or cue-based models, may be needed once empirical data are available. The value of the present model is that it makes the competing hypotheses explicit before data are collected and forces the analysis to state which learner outputs should cluster together if the proposed ranking is correct.

2.5 Research gap and contribution

Existing work gives strong reasons to expect difficulty with English vowels in multilingual settings, but it does not yet provide a compact formal model for the English high-vowel problem in Moroccan repertoires. Studies of L2 speech learning explain why new categories may be assimilated to old ones, and studies of L3 phonology explain why several previous languages may remain active. What is still needed is a model that translates those general claims into specific predictions for /i:-ɪ/ and /u:-ʊ/. Without such a model, empirical research may collect useful acoustic data but leave the logic of expected learner patterns under-

specified. For example, if a learner produces ship with [i], the result may be described as substitution, merger, spelling effect, or transfer. A constraint-based model asks a sharper question: which ranking would make that output optimal, and what other outputs should follow from the same ranking?

The present article contributes to this gap in three ways. First, it treats Moroccan learners as multilingual rather than as speakers of one background language. This matters because Tashlhiyt, Moroccan Arabic, and French do not contribute identical phonological resources, even when they converge on the absence of English-like high lax vowels. Second, it separates vowel quality from duration. This separation is important because English high-vowel contrasts are often taught as long versus short, whereas the target contrast is more complex. Third, it links the OT analysis to L3 transfer models instead of presenting tableaux as self-sufficient explanations. The aim is not to prove that a particular learner group already has a particular ranking. The aim is to offer a disciplined framework that future data can test. In this sense, the article is positioned between theoretical phonology and applied pronunciation research: it uses formal tools to make empirical expectations clearer.

The argument is also designed to be modest enough for a theoretical article. It does not claim that Moroccan learners are deficient, nor does it assume that the goal of English learning must be native-like pronunciation in every respect. The issue is contrast formation. In contexts where English lexical contrasts depend on /i:-ɪ/ and /u:-ʊ/, learners need a system that can keep the relevant contrasts apart for perception, production, and intelligibility. A formal analysis can show why some contrasts are likely to be more fragile than others without turning pronunciation into a judgement of speaker value. This distinction is important for applied linguistics audiences because it connects phonological theory to communicative and pedagogical relevance while avoiding a deficit view of multilingual speakers.

3. Methodology

3.1 Design of the theoretical analysis

This article is a theoretical and analytical study. It does not collect new human-participant data and does not report experimental results. Its method consists of comparative phonological analysis, constraint formulation, and hypothesis derivation. The target system is the English high-vowel set /i:, ɪ, u:, ʊ/. The source systems considered are Tashlhiyt, Moroccan Arabic, and French because these are central components of many Moroccan multilingual learner profiles and because each is relevant to the high-vowel problem. Modern Standard Arabic is acknowledged as part of the broader repertoire, but it is not modelled separately here. Adding it as a fourth source would make the article less focused while not changing the central high-vowel asymmetry: the background systems still do not provide a direct English-like four-way high-vowel contrast.

The analysis proceeds in four steps. First, it identifies the properties that must be preserved for target-like English high vowels: place, tense-lax quality, and duration-bearing moraic structure. Second, it formulates a restricted set of OT constraints needed to derive the relevant outputs. Third, it compares a baseline transfer ranking with two intermediate rerankings and a target-oriented ranking. Fourth, it interprets the rankings under the L2 Status Factor, the Cumulative Enhancement Model, the Typological Primacy Model, and the Linguistic Proximity Model. The resulting model is predictive rather than descriptive. It specifies the patterns that future perception and production data should confirm, refine, or disconfirm.

The methodological choice to use OT also requires caution. A tableau is not a direct image of the learner's mind; it is an explicit representation of a hypothesis about the relation between input, candidate outputs, and constraint ranking. The model is therefore evaluated indirectly. If the baseline ranking is correct for some learners, several outputs should pattern together: lax high vowels should be peripheralised, long tense vowels should be shortened, and place should be more stable than quality or duration. If only one of these patterns appears, the ranking must be revised. This makes the analysis falsifiable rather than merely descriptive.

3.2 Representational assumptions

Two representational assumptions are necessary. First, the term tense-lax is used as a cover label for the quality distinction within each high-vowel pair. IDENT-IO(TENSE) therefore means that the output preserves membership in the English tense-lax quality opposition. It does not assert that tenseness is universally reducible to tongue-root advancement, muscular tension, or any single phonetic correlate. Second, the length specification of /i:/ and /u:/ is represented moraically. Long tense vowels are treated as bimoraic and their lax counterparts as monomoraic for the limited purpose of modelling preservation or loss of duration-bearing structure (Hayes, 1989). These assumptions allow quality and duration to be separated formally while remaining compatible with the fact that English listeners and speakers often use several cues together.

The proposed grammar is deliberately restricted. It is not a full OT grammar of Tashlhiyt, Moroccan Arabic, French, or English. It is a high-vowel transfer schema. This restriction prevents the misleading impression that a few constraints reconstruct complete source-language phonologies. The constraints are selected only because they are needed to express the central hypothesis: learners may initially preserve high-vowel place while failing to preserve English lax quality and long-vowel moraic structure.

Constraint	Definition	Role in the analysis
IDENT-IO(PLACE)	Corresponding input and output vowels agree in frontness/backness and rounding.	Blocks substitutions such as [ə] for a high peripheral input.
IDENT-IO(TENSE)	Corresponding vowels preserve membership in the English tense-lax quality opposition.	Protects /i:-ɪ/ and /u:-ʊ/ quality differences.
MAX-μ	Every input mora has an output correspondent.	Protects the additional mora of /i:/ and /u:/.
DEP-μ	Every output mora has an input correspondent.	Prevents spurious lengthening of lax vowels.
*HI-LAX	Assign one violation to a high lax output [ɪ] or [ʊ].	Encodes the source-compatible absence of high lax lexical categories.
*V:	Assign one violation to a bimoraic vowel.	Encodes a source-compatible preference against contrastive long vowels.

Table 2. Constraint set.

*Analytical qualification. TENSE is a cover term for the English quality opposition and does not reduce the contrast to a single articulatory feature. The constraint *HI-LAX represents the proposed transfer schema; it does not claim that [ɪ] and [ʊ] are universally prohibited.*

3.3 Analytical limits

Because the article is theoretical, it does not establish the actual productions or perceptions of Moroccan learners. It also does not claim that every learner follows the same path. Differences in dominance, age of acquisition, French proficiency, English exposure, phonetic instruction, target variety, and orthographic knowledge may all affect outcomes. The model should therefore be read as a structured hypothesis space. Its strength lies in making predicted patterns explicit: complete merger, duration-first development, quality-first development, and target-oriented separation. Future empirical work can then test which rankings are most compatible with particular learner profiles.

4. Results and Discussion

4.1 Baseline transfer grammar: complete merger

The baseline transfer grammar ranks source-compatible markedness above the faithfulness constraints that would preserve English high-vowel quality and length. The crucial ranking is shown in (1). IDENT-IO(PLACE) and DEP-μ are placed high so that front unrounded inputs remain front and unrounded, back rounded inputs remain back and rounded, and spurious lengthening of lax vowels is avoided.

(1) IDENT-IO(PLACE), DEP-μ, *HI-LAX, *V: >> IDENT-IO(TENSE), MAX-μ

For a lax input such as /ɪ/, high-ranked *HI-LAX favours replacement by the corresponding peripheral vowel. The faithful [ɪ] loses because it violates a high-ranked markedness constraint, while [i] violates only lower-ranked quality faithfulness. A central [ə] candidate is excluded by place faithfulness. For a long tense input such as /i:/, high-ranked *V: favours shortening. The output [i] therefore wins over [i:] because preserving the additional mora would violate a higher-ranked markedness constraint. The same logic applies to /ʊ/ and /u:/. The predicted baseline inventory compresses the four English targets into two high-vowel categories: /i:/, /ɪ/ map to [i], and /u:/, /ʊ/ map to [u].

This outcome is consistent with the shared structural facts of the source systems. The analysis does not require Tashlhiyt, Moroccan Arabic, and French to be identical. It requires only that all three support peripheral high vowels while lacking direct high lax counterparts. The baseline grammar is therefore compatible with several source histories. A surface merger alone cannot identify whether the learner is drawing primarily on Tashlhiyt, Moroccan Arabic, French, or a convergent multilingual representation.

/ɪ/	IDENT-IO(PLACE)	*HI-LAX	IDENT-IO(TENSE)
[ɪ]		*!	
 [i]			*
[ə]	*!		*

Tableau 1. Baseline mapping of English /ɪ/ to [i].

/i:/	IDENT-IO(PLACE)	*V:	MAX-μ
[i:]		*!	
 [i]			*
[ɪ]		*	*!

Tableau 2. Baseline shortening of English /i:/.

/ʊ/	IDENT-IO(PLACE)	*HI-LAX	IDENT-IO(TENSE)
[ʊ]		*!	
 [u]			*
[ə]	*!		*

Tableau 3. Baseline mapping of English /ʊ/ to [u].

/u:/	IDENT-IO(PLACE)	*V:	MAX-μ
[u:]		*!	
 [u]			*
[ʊ]		*	*!

Tableau 4. Baseline shortening of English /u:/.

Note. An asterisk marks a violation; an exclamation mark marks a fatal violation; the pointing hand marks the optimal candidate.

4.2 Duration-first and quality-first intermediate grammars

The main advantage of separating IDENT-IO(TENSE) from MAX-μ is that the analysis predicts more than one developmental route. Learners need not move directly from complete merger to a target-oriented four-category system. If MAX-μ is promoted before IDENT-IO(TENSE), the grammar preserves the moraic structure of /i:/ and /u:/ while still replacing /ɪ/ and /ʊ/ with peripheral [i] and [u]. This duration-first grammar predicts [i:] versus [i] and [u:] versus [u]. Acoustically, such learners should show duration differences with weak or unstable spectral separation.

If IDENT-IO(TENSE) is promoted before MAX-μ, the grammar preserves the tense-lax quality distinction while still shortening long vowels. This quality-first grammar predicts [i] versus [ɪ] and [u] versus [ʊ], but without a target-like durational ratio. Acoustically, such learners should show more spectral differentiation than duration differentiation. Neither intermediate grammar is presented as an obligatory chronological stage. They are possible states in the hypothesis space. Different learners may promote constraints in different orders, use multiple cue strategies, or show probabilistic variation that categorical tableaux cannot fully represent.

A target-oriented ranking emerges when IDENT-IO(TENSE) and MAX- μ both dominate the relevant markedness constraints. Under this ranking, high lax vowels are permitted despite their markedness, and the mora of long tense vowels is preserved. The system can then maintain /i:/, ɪ, u:, ʊ/ as four distinct categories. Importantly, the markedness constraints do not disappear from the grammar. They remain available but no longer determine the winner when they conflict with higher-ranked target faithfulness.

/i:/	MAX- μ	*V:	IDENT-IO(TENSE)
ⵉ [i:]		*	
[i]	*!		
[ɪ]	*!		*

Tableau 5. Duration-first preservation of /i:/.

/ɪ/	IDENT-IO(TENSE)	*HI-LAX	IDENT-IO(PLACE)
ⵉ [ɪ]		*	
[i]	*!		
[ə]			*!

Tableau 6. Quality-first preservation of /ɪ/.

Grammar	Crucial ranking	Front outputs	Back outputs	Primary prediction
Baseline merger	*HI-LAX, *V: >> IDENT-IO(TENSE), MAX- μ	/i:/, ɪ/ → [i]	/u:/, ʊ/ → [u]	No reliable quality or duration contrast
Duration-first	MAX- μ >> *V:; *HI-LAX >> IDENT-IO(TENSE)	/i:/ → [i:]; /ɪ/ → [i]	/u:/ → [u:]; /ʊ/ → [u]	Duration contrast with weak quality separation
Quality-first	IDENT-IO(TENSE) >> *HI-LAX; *V: >> MAX- μ	/i:/ → [i]; /ɪ/ → [ɪ]	/u:/ → [u]; /ʊ/ → [ʊ]	Quality contrast with reduced length difference
Target-oriented	IDENT-IO(TENSE), MAX- μ >> *HI-LAX, *V:	/i:/ → [i:]; /ɪ/ → [ɪ]	/u:/ → [u:]; /ʊ/ → [ʊ]	Both spectral and durational differentiation

Table 3. Predicted developmental grammars.

4.3 Coupling OT rankings with multilingual transfer models

The OT rankings become more informative when connected to theories of source selection. The L2 Status Factor predicts that French may be privileged when it is the learner's established non-native language. In the present analysis, that would mean French can support peripheral [i] and [u] targets and may influence the phonetic quality of English tense vowels. However, French should not independently create target-like /ɪ/ and /ʊ/ because those categories are not part of the French system. A strong French effect may therefore improve tense-vowel quality while leaving the full tense-lax contrast incomplete.

The Cumulative Enhancement Model predicts that any prior language can facilitate a compatible property. This fits the shared support for peripheral high place: Tashlhiyt, Moroccan Arabic, and French can all contribute to [i] and [u]-like targets. The Typological Primacy Model (Rothman, 2011) would predict a more coherent transfer pattern from the language selected as globally closest to English. Although the model was originally formulated for morphosyntactic transfer, its central claim about typology-based source selection provides a useful comparative hypothesis for phonology. If this account is correct for a learner group, transfer effects should align across several vowel properties and perhaps across other phonological domains. The Linguistic Proximity Model is especially compatible with the present account because it allows place, quality, and duration to receive support from different previous languages. The model therefore predicts crossed effects: French proficiency may

relate to vowel quality, while dominance in Tashlhiyt or Moroccan Arabic may relate to different patterns of category compression or timing.

This coupling of OT and transfer theory clarifies their separate roles. OT specifies what a ranking generates. L3 transfer models specify why a ranking or property may be available. Without OT, source-selection models may remain too general to predict concrete outputs. Without transfer theory, OT tableaux may derive outputs without explaining why a learner would begin from a particular ranking. The proposed account therefore treats formal constraint evaluation and multilingual source selection as complementary rather than competing explanations.

Account	Source prediction	Expected OT interpretation	Potential diagnostic
L2 Status Factor	French receives privileged activation as the established non-native language.	French-compatible support for peripheral [i, u], without high lax or length oppositions.	Tense vowels cluster closer to French categories as French proficiency increases.
Cumulative Enhancement Model	Any previous language may facilitate a compatible target property.	Shared support for IDENT-IO(PLACE) in /i:/, u:/.	Facilitation is strongest for properties shared across the repertoire.
Typological Primacy Model	One background language is selected through global structural proximity.	The initial high-vowel ranking is inherited from the selected system.	Transfer effects cohere across vowel properties and other phonological domains.
Linguistic Proximity Model	Influence is property-specific and may come from more than one language.	Place, quality, and duration may receive different sources of support.	Quality and duration correlate with different background-language measures.

Table 4. Source-selection models and the proposed OT grammar.

4.4 Empirical predictions and research implications

The proposed analysis produces several testable predictions. First, early or source-dominant learners should show category compression within /i:-ɪ/ and /u:-ʊ/. This compression may appear in production as overlapping F1 and F2 values, in perception as identification confusion, or in both. Second, place should be more stable than tense-lax quality because all source systems provide peripheral high vowels. Errors are therefore expected to preserve frontness and rounding more reliably than the English tense-lax distinction.

Third, quality and duration should dissociate in at least some learner profiles. A duration-first learner may distinguish sheep from ship mainly through length while producing similar vowel qualities. A quality-first learner may produce more target-like spectral separation without the expected duration ratio. This prediction is especially important because classroom explanations often present the contrast as long versus short. A duration-only teaching strategy may encourage one part of the target contrast while leaving lax vowel quality underdeveloped.

Fourth, French proficiency should not be expected to improve all four targets equally. It may support English /i:/ and /u:/ more strongly than /ɪ/ and /ʊ/. Fifth, no single background-language measure should explain the entire pattern if property-by-property transfer is correct. A future empirical study should therefore collect language-history, language-dominance, French exposure, English exposure, phonetic-training, and task-condition information rather than grouping participants only by nationality or broad L1 label. This point follows recent L3 phonology findings showing that source selection may vary by feature and by individual learner (Wrembel et al., 2020; Kopečková et al., 2023).

A suitable research design would combine perception and production. Production tasks should include multiple lexical items for /i:/, ɪ, u:/, ʊ/ in controlled consonantal contexts, with acoustic measures of midpoint F1, F2, duration, and, where relevant, spectral trajectories. Perception tasks should include identification or discrimination procedures that show whether learners represent four categories even when their productions overlap. This is important because recent L2 speech-learning work treats perception and production as related but not

perfectly identical systems (Flege & Bohn, 2021; Uchihara, Karas, & Thomson, 2024). Speaker-level analysis is necessary because a group mean may conceal coexisting duration-first, quality-first, and merged grammars. The proposed OT model is therefore not a substitute for data collection; it is a way of making data collection more theoretically targeted.

The predictions also have consequences for statistical modelling. If future data are collected, the dependent measures should not be reduced to a single pronunciation accuracy score. A binary correct/incorrect score may be useful for a broad overview, but it cannot distinguish a duration-first learner from a quality-first learner. Acoustic measures should therefore be analysed separately before being combined into any global index. Mixed-effects models would be useful because they can account for repeated words and repeated speakers while testing the effects of language background, French exposure, academic level, task type, and phonetic training. Such modelling would be particularly valuable for testing whether one background-language variable predicts all aspects of the contrast or whether quality and duration have different predictors.

The model also encourages careful treatment of English variety. The article uses British-oriented phonological labels because /i:-ɪ/ and /u:-ʊ/ are familiar in many university phonetics courses, but production targets should be defined clearly in any empirical extension. If British and American models are mixed without explicit scoring rules, the interpretation of /u:/ fronting, vowel duration, and lexical distribution may become unclear. A future study should therefore specify the target variety, the reference speakers, and the acoustic criteria used for evaluation.

Prediction	OT source	Minimum evidence needed	Outcome that would challenge the proposal
Early overlap within each tense-lax pair	Markedness dominates IDENT-IO(TENSE) and MAX-μ.	Acoustic production or identification/confusion data	Stable four-way separation among low-exposure learners
Better place approximation for /i:, u:/ than for /ɪ, ʊ/	Shared peripheral categories support IDENT-IO(PLACE).	Formant-distance comparison with source and target references	Lax vowels consistently more target-like than tense vowels
Duration-first and quality-first learner profiles	MAX-μ and IDENT-IO(TENSE) rerank independently.	Speaker-level formant and duration measures	Quality and duration always change as a single inseparable cue
French helps tense quality but not the complete contrast	L2-based transfer supports [i, u] but not high lax categories.	French proficiency plus multilingual acoustic data	French proficiency independently predicts target-like /ɪ, ʊ/
Different predictors for quality and duration	Property-by-property transfer under the LPM	Language history, dominance, proficiency, and mixed-effects modelling	One source uniformly predicts every property and contrast
Task-sensitive CLI	Dominant articulatory routines become more visible under heavier processing demands.	Compare word reading, sentence reading, and delayed repetition	Identical outputs across tasks despite different cognitive demands
Perception-production mismatch	Cue reranking may advance in perception before production, or production before perception.	Matched identification/discrimination and acoustic production measures	Perfect alignment between perception and production for all learners

Table 5. Empirical predictions derived from the ranking analysis.

4.5 Pedagogical relevance

Although the article is primarily theoretical, it has practical implications for English pronunciation instruction in Moroccan university contexts. The high-vowel pairs should not be taught as if duration alone were the whole contrast. Learners need attention to vowel quality, duration, lexical distribution, and listening-based category formation. Minimal-pair practice can be useful, but it should be accompanied by guided perception work and visual or acoustic feedback where possible. Teachers should also be cautious when using French, Arabic, or

Amazigh approximations. Such approximations may help learners approach /i:/ and /u:/, but they do not automatically solve the lax vowel problem. The theoretical prediction is simple: a learner can sound more target-like on tense vowels while still merging the contrast. Instruction should therefore aim at contrast formation rather than isolated sound imitation.

The recent literature also supports an early and perception-rich approach. Tyler (2019), applying PAM-L2 to the foreign-language classroom, argues that learners need opportunities to discover the phonetic differences that signal L2 phonological contrast before a large vocabulary has already been established. This is relevant to Moroccan EFL learners because many students encounter English vowel symbols late, after years of learning vocabulary through orthography. Explicit work on ship-sheep, full-fool, live-leave, and pull-pool should therefore begin before spelling-driven mappings become too stable. Such work should not simply ask learners to repeat words; it should help them hear, categorise, and then produce the contrast.

Implementing perception-rich instruction in large Moroccan university classes nevertheless presents practical challenges. Contact hours may be limited, classes may contain many students, and teachers may lack language laboratories, specialised acoustic software, reliable classroom audio equipment, or enough time to provide individual diagnostic feedback. Students' access to internet-connected devices and quiet practice environments may also be uneven. A scalable approach would therefore rely on brief but repeated listening cycles, reusable recordings, pair or small-group discrimination activities, and periodic whole-class feedback rather than continuous one-to-one acoustic analysis. These constraints do not weaken the recommendation for early perceptual work, but they require it to be adapted to the resources and class sizes of the local teaching context.

High-variability phonetic training is one possible pedagogical extension, but it should be used carefully. Uchihara et al. (2024) find that perception-based high-variability training can produce small-to-medium gains in L2 speech production, while generalisation to untrained items and long-term retention are not guaranteed. For the present article, this means that training should include several speakers, several consonantal environments, and both perception and production practice. Short classroom drills may raise awareness, but they are unlikely to restructure the learner's vowel system unless they are repeated, varied, and connected to feedback.

The implications should also be framed ethically. The goal is not to erase Moroccan, Amazigh, Arabic, or French-accented identities. A multilingual accent is not a problem in itself. The pedagogical issue is whether learners can maintain lexical contrasts that matter for intelligibility and academic communication. A contrast-based approach allows teachers to focus on communicative distinctions without presenting native-like pronunciation as the only acceptable outcome. This makes the theoretical analysis more useful for applied linguistics: it identifies where contrast loss is likely, why it is likely, and how instruction can respond without adopting a deficit view of multilingual learners.

4.6 Limitations of the proposal

The model is intentionally idealised. First, it uses a cover feature, TENSE, for the English quality distinction, although the contrast is phonetically multidimensional and theoretically contested. A more detailed future account may replace IDENT-IO(TENSE) with constraints referring to height, centralisation, peripheralness, or cue weighting. Second, categorical OT does not represent gradient category overlap, variable productions, lexical frequency, or sociophonetic variation. Third, the source-language descriptions are simplified. Tashlhiyt, Moroccan Arabic, French, and English all show dialectal and social variation, and individual learner histories may make one system more active than another. Finally, the analysis begins with target-oriented inputs and does not model how learners perceive non-native acoustic signals before building phonological representations. These limitations are not minor, but they define what the present article can and cannot claim.

5. Conclusion

This article has proposed a restricted OT account of English high-vowel acquisition in Moroccan multilingual phonology. The central observation is that Tashlhiyt, Moroccan Arabic, and French can all support peripheral high vowels, but none supplies the complete English /i:, ɪ, u:, ʊ/ system. A baseline transfer grammar in which *HI-LAX and *V: dominate IDENT-IO(TENSE) and MAX- μ predicts merger of /i:-ɪ/ to [i] and /u:-ʊ/ to [u]. Independent promotion of MAX- μ yields a duration-first grammar, while promotion of IDENT-IO(TENSE) yields a quality-first grammar. A target-oriented grammar is reached only when both quality and duration faithfulness dominate the relevant markedness constraints.

The strengthened theoretical argument is that OT becomes more useful when it is coupled with recent L3 phonological research rather than presented as a closed formal system. Current work on L3 speech learning shows that transfer can be feature-sensitive, task-sensitive, and individually variable. This fits the present proposal because the English high-vowel contrast is not a single learning object: it involves place, quality, duration, and the integration of perception and production. OT explains what a ranking produces; L3 transfer models and speech-learning models explain why particular rankings or properties may become active for particular learners.

The proposal remains falsifiable. Evidence that low-exposure learners consistently maintain four categories, that French proficiency alone creates target-like /ɪ/ and /ʊ/, or that quality and duration always develop as one inseparable cue would require substantial revision. For that reason, the value of the article lies not in claiming final empirical facts about Moroccan learners but in offering a precise formal map for future perception and production research. Its applied value is equally specific: it recommends contrast-oriented instruction that treats pronunciation as intelligibility, cue learning, and category formation, not as a demand for native-like speech.

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Abbreviations

CEM = Cumulative Enhancement Model; CLI = cross-linguistic influence; CON = constraint set; EVAL = evaluation component; GEN = generator; IDENT-IO = input-output identity; L2 = second language; L3 = third language; LPM = Linguistic Proximity Model; MAX- μ = mora-preservation constraint; OT = Optimality Theory; TPM = Typological Primacy Model.

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