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| RESEARCH ARTICLE

An Optimality-Theoretic Analysis of Word-stress Learnability: Evidence from Moroccan-English Interlanguage

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| ABSTRACT
This study adopts a theoretical analysis of the learnability of English word-stress. It intends to provide an Optimality-theoretic analysis of word-stress learnability among Moroccan learners of English. Language acquisition, from an Optimality Theory perspective, is a process of reordering the constraints from an initial state of the grammar to the language-specific ranking of the target grammar. To account for stress development, this paper makes use of the Constraint Demotion Algorithm (Tesar & Smolensky, 1996; 2000), which learners adopt to infer the correct hierarchy of constraints. Starting with a default hierarchy supplied by Universal Grammar, learners proceed with the recursive demotion of higher-ranked constraints until the correct ranking is reached. The algorithm, starting by initializing the hierarchy, assumes that constraints are unranked and thus hosted in the same stratum. Sixty Moroccan learners participated in the study. The informants are third-year students at Ibn Tofail University. They were administered an oral multiple-choice test that elicited their intuition about English stress patterns. The overall findings of the study reveal that learners' prior (L1) ranking influences their learnability of English stress. That is, Moroccan learners misplace stress in English words due to the initial state of their grammar. From the findings, OT is evidenced to successfully predict learning stages using CDA, wherein each demotion signals a learning stage.

| KEYWORDS

English stress, Optimality Theory, Constraint Demotion Algorithm, Stress assignment, Moroccan Arabic.

| ARTICLE INFORMATION

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1. Introduction

The acquisition of phonology has recently received a fast-growing essence. This area of research lies at the heart of the modern study of language. Research on second language (L2)[1] phonology has thrived as this field has intrigued linguists, practitioners, and educators. This growing interest in L2 phonology stems from the belief that correct pronunciation is influential in the development of language (see Eckman, 2004). Lately, the phonological acquisition has witnessed an ever-increasing revival of interest. The emergence of constraint-based models, in particular, Prince and Smolensky's (1993) Optimality Theory (henceforth, OT), has played a central role in this revival.

In spite of the interest in the acquisition of L2 phonology, the published literature remains scarce in the Moroccan context. The present study, thus, endeavours to enrich the existing body of research at the level of L2 sounds acquisition. By investigating a suprasegmental feature (word-stress) acquisition, this study attempts to fill the gap of focusing solely on studying the acquisition of segments. Conducting this study has been primarily motivated by a 'teaching' practice and by the identification of the gap in the literature. From the practical perspective, it has been first sparked by the observations of the researcher regarding the mastery of English stress by Moroccan learners. As a practitioner, when teaching aspects of the suprasegmentals of English (e.g., sentence

[1] In line with the North-American tradition, L2 is used to refer to any language that is acquired after L1.

stress, word stress, pitch), classroom instruction becomes a mere remedial task; correction of students' errors. As far as the theoretical perspective is concerned, this study has been motivated by the scarcity of research in this area, especially in the Moroccan context. The analysis proposed in this study is distinguished from previous analyses in applying a constraint-based analysis. Exploring the interaction of English and Moroccan Arabic (MA) on Moroccan learners' interlanguage (hereafter, IL) could yield considerable findings on the role of Universal Grammar (henceforth, UG) on language acquisition and the different stages of L2 phonological acquisition.

Further reasons stand behind the exploration of learners' learnability of English stress. In the Moroccan context, to the best knowledge of the researcher, the exploration of the acquisition of suprasegmental aspects is understudied. Since previous (published) works have primarily focused on the segmental levels, the present study intends to enrich the existing body of literature in the Moroccan context on L2 phonology acquisition by exploring the learnability of word stress. Both segmental and suprasegmental aspects are significant in the understanding of language (see Derwing, Munro, & Wiebe, 1998). Segmental errors can lead to communication breakdowns (Derwing & Munro, 1997, 2006, 2015; Rogers, Dalby, & Nishi, 2004). Likewise, word stress can preclude full intelligibility of speech, for it helps listeners process the segmental content by adding structure to the varying speech signals (Celce-Murcia, Brinton, & Goodwin, 1996; Lepage, 2015).

The analysis of how prosodic properties of typologically distant languages can affect each other requires a model of phonological acquisition that can abstract away from the surface differences between their stress patterns. The model adopted for this purpose is Optimality Theory. OT explains linguistic grammar as a set of universal violable constraints. From an OT perspective, the difference between the two languages lies in the different ordering of the same universal constraints. For example, while stress assignment in both English and MA is subjected to universal constraints, they differ in how they rank these shared constraints. Under this view, L2 acquisition is regarded as a process of re-ranking the constraints from the L1 state towards the L2 state. Assuming that the stress pattern of MA and English is interpreted by the same constraints, the researcher can predict stress development among Moroccan learners of English.

The overall aim of this study is to account for the learnability of English word-stress among Moroccan learners of English. To achieve this aim, the analysis adopts the Constraint Demotion Algorithm (hereafter, CDA) (Tesar & Smolensky 2000). The analysis looks into how learners handle the conflict between the constraints that determine stress location in moving from the initial state to the final state. Section (5) furthers this algorithm.

The organization of this paper can be seen along the following lines. Section 2 introduces the theoretical background necessary in undertaking the analysis of stress learnability. This section reviews the development of L2 acquisition approaches. Additionally, it introduces the framework adopted in this study and the algorithm used in stress learnability à la OT. It also provides some comparative generalizations about stress in MA and English. Section 3 presents the methodology employed in this study. It spotlights the research problem investigated, the research questions enquired, the participants under study, and the instrument employed in this paper. While section 4 provides a presentation of the data, section 5 offers an analysis and a discussion of the results in light of CDA. Section 6 concludes the paper by providing succinct pedagogical implications of the findings.

2. Literature review

2.1. Approaches to the acquisition of second language phonology

The field of phonology acquisition is very interdisciplinary, and approaches differ drastically. In the last decades, several different theoretical frameworks have been employed in studies on the acquisition of phonology. Research in L2 phonology has been approached differently, starting from Contrastive Analysis (Fries, 1945; Lado, 1957) to the most recent framework OT (Archibald, 1997a, 1997b; Broselow et al., 1998; Escuerdo & Boersma, 2001, 2004; Broselow, 2004). Whereas some have investigated the acquisition of segments (Best, 1995; Flege, 1995; Amrous, 2012), others have studied prosodic aspects of interlanguage (Archibald, 1997a, 1997b) with the assumption that UG is heavily involved in L2. It follows that learners' L1 has some influences on the accuracy achieved in L2 sounds and that the initial state of learners' interlanguage is actually the grammar of their L1.

The learnability of L2 phonology is conducted at least within four theoretical frameworks. Contrastive Analysis (CA) (Lado, 1957) was the first model that endeavoured to explore how the comparison of L1 and L2 systems can predict and describe the patterns which cause difficulty in learning. Some linguists (e.g., Flege, 1995; Best & Tyler, 2007; Faris et al., 2018) consider that this influence lies in similarities between L1 and L2, while others (e.g. Lado, 1957; Eckman, 1977; Major, 1987 2001; Brown, 1998) ascribe the errors to dissimilarities between L1 and L2 grammar. While the similarities of phonological features between L1 and L2 facilitate learning, the dissimilarities of phonological features pose difficulty in acquiring the features that are not shared in their L1 (Lado, 1957).

Unlike CA, Flege (1991) proposes a Speech Learning Model (SLM) to account for the acquisition of L2 phonology. SLM assumes that phonological errors are not induced due to dissimilar sounds between L1 and L2 but are traceable to similar sounds. As summed up in Amrous (2012), the argument is that similar sounds are stored and articulated relying on the already existing sounds in L1 without creating a new L2 phonetic category. On the other hand, the acquisition of dissimilar sounds mandates creating a new sound with specific phonetic properties. For instance, a Moroccan Arabic speaker would be more likely to establish a phonetic category for English /æ/ or /ɔ/ than for English /i/ (which differs only slightly from MA /i/) because only three underlying vowels /a, i, u/ and epenthetic schwa are attested in MA (Benhallam, 1989/1990; Boudlal, 2006/2007/ 2011; Bensoukas & Boudlal, 2012).

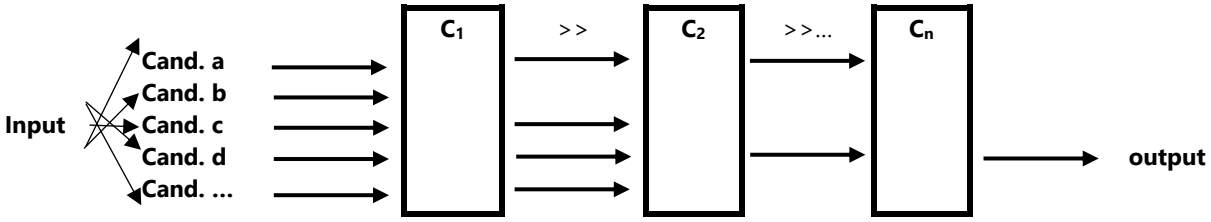
A different perspective on the acquisition of L2 phonology is given in Eckman's (1997) Markedness Differential Hypothesis (MDH) framework. The assumption that underlies the notion of markedness is that some linguistic features are universal and shared in all natural languages. L2 phonology difficulties are predicted on the basis of UG markedness relation. It follows that learning marked segments (less frequent) are more difficult than the corresponding unmarked segments (frequent). The assumption is that unmarked structures are acquired before marked ones.

The most recent model adopted in accounting for L2 acquisition is OT. Research that espouses OT makes use of constraints interaction (Archibald, 1997a, 1997b, 2003; Broselow et al., 1998; Hancin-Bhatt, 2000; Escuerdo & Boersma, 2001; Amrous, 2012; Broselow & Xu, 2004; Broselow, 2018). Besides being a model for grammar explanation, OT can provide an adequate analysis of language acquisition. Employing learning algorithms, learners, if need be, reorder constraints on the input until they reach the correct (optimal) output. The following section discusses OT as the framework that is adopted in this study.

2.2. Optimality theory

The developments in phonological theory were crucial to the emergence of OT (McCarthy & Prince, 1993, 1995, 1999; Prince & Smolensky, 1993/2004 and related works). OT proposes that the observed language forms arise from the interaction of conflicts between competing constraints rather than rule derivation. In OT, the optimal/harmonic output is the form that results from the minimal violation of strictly ordered constraints. It follows that a candidate may violate some constraints, but it can still surface as optimal in case the constraint(s) it satisfies is high ranked. To map an input to output, OT operates as follows:

(1) Mapping of input to output in OT grammar (Kager, 1999, p. 8)



The set of candidate forms, generated by means of Gen(erator), are evaluated using Eval to determine the optimal candidate (actual output). As in (1), the evaluation uses a set of hierarchically ranked constraints $C_1>>C_2>>\ldots. C_n$ (where **>>** denotes that the domination relation 'higher than'). This evaluation process is made by means of constraint tableau. A given input appears at the top of the left of the constraints; below the input is the set of candidates, one of which is optimal. The top row displays the constraints in the hierarchy from left to right. A solid line represents the hierarchy order. The remaining cells exhibit the evaluation, where the asterisk (*) marks the violation. A fatal violation is marked by an exclamation mark (*!) or shaded cells for the lower-ranked constraints. A pointing-hand (☞) designates the optimal candidate. Consider tableau (2).

(2)

Input	C_1	C_2	C_3
☞ Cand. a	*	*	***
Cand. b	*	**!	

In (2), the optimal candidate is *Cand. a* because it fares better on the highest-ranking constraint. While *Cand. a* incurs fewer violations of C_2, *Cand. b* fatally violates the same constraint. The ordering is strictly respected in evaluating the candidates. *Cand. a* incurs more violations to C_3 than its competitor, but it is ranked below the decisive one. *Cand. a* is optimal as it incurs fewer violations of C_2, which dominates C_3.

2.3. Learnability in OT: Constraint Demotion Algorithm

Prior to OT is the principle of constraint strict ranking. The difference between languages lies in the ordering of the universal constraints in their language-specific dominance hierarchies (Tesar & Smolensky, 1996). Under the assumption of the innateness of the universal constraints, L2 acquisition is primarily "to learn the language-specific ranking of the universal constraints" Tesar and Smolensky (1996, p.1). From an OT perspective, learnability is a process of reranking these constraints from an initial state of the grammar to the language-specific ranking of the target grammar.

Constraint Demotion Algorithm (CDA) (Tesar, 1998, 1999, 2000; Tesar & Smolensky, 2000), one of the prominent learning algorithms within OT, defines L2 acquisition as a process of reordering the existing constraints. According to CDA, learners first start by establishing an initial hierarchy at the initial state. Since constraints are universal, the initial state of L2 acquisition is believed to correspond to the final state of L1. In the next stage, learners, by means of Robust Interpretive Parsing (RIP), map the overt form they perceive to a full structural description. In the third stage, Grammar Learning, learners deduce the constraint hierarchy of the L2 based on negative and positive evidence from constraint violation (Kager, 1999). To achieve this aim, learners use Constraint Demotion, which mandates demoting every winner-favouring constraint below some loser-favouring constraint until all winner-favouring constraints are dominated.

The constraints violated by the optimal candidate must be demoted steps below those violated by its competitors. In OT literature, this is also explained by the notion of the *stratum*. While constraints within a stratum are non-conflicting, strata are ranked with respect to other strata. A hierarchy containing strata is termed a *stratified hierarchy*. Constraints are demoted only when necessary; suppose that, at a stage, constraints 1 and 2, among others, are housed in the same stratum as in (3 a), where C1 is violated by the optimal form and C2 by the suboptimal forms. This entails that constraint C2 dominates C1, C1 consequently demotes below C2 to the immediate stratum as in (3b):

(3) a. Stratum 1 {C3, C1, C2, C6} **>>** Stratum 2 {C4, C5}

b. Stratum 1 {C3, C2, C6} **>>** Stratum 2 {C4, C5, C1}

Learners continue to demote constraints until no negative evidence arises for further demotion to take place.

2.4. Stress in English and MA

2.4.1. Stress in MA

Studies on stress in MA remain scarce. Following Benhallam's (1990) taxonomy works on MA stress are either **impressionistic** (Abdelmassih, 1973; Benkaddour, 1982; Fares, 1993; El Hadri, 1993; Benhallam, 1990b) or **instrumental** (Benkirane, 1982; Hammoumi, 1988; Nejmi, 1993, 1995; Boudlal, 2001; Kably, 2001). MA can have both iambic and trochaic feet depending on whether or not the word is in context or in isolation (Boudlal, 2001). Stress location is triggered by two factors: syllable position and syllable weight. What follows draws the generalizations of stress in MA from these works.

i. MA is quantity sensitive language (Abdelmassih, 1973; Benkaddour, 1982; El Hadri, 1993; Benhallam, 1990b; Hammoumi, 1988; Nejmi, 1993, 1995; Boudlal, 2001; Bohas et al., 1989, Bouziri 1991, Kably 2001); stress is sensitive to syllable weight.
ii. Stress is restrictively located on one of the last two syllables of a word (Boudlal, 2001).
iii. Stress falls on the ultimate syllable if it is heavy ([lawjín] 'wilted, pl.'); otherwise, on the penultimate ([láwja] 'wiled, fem. Sg.') (Boudlal, 2001; Benkirane, 1982, Benhallam, 1990b).
iv. If the penultimate syllable is an object clitic, stress falls on the preceding syllable as in [kərkbíhalhum] 'roll (2 fem.sg.) it for them' (Benhallam, 1990b).
v. When the word has a closed syllable with schwa as a nucleus, it is considered a light syllable. Hence, it never attracts stress if there is a syllable with a full vowel, as in [májəl] or [wáʕdək] (Boudlal, 2001).
vi. Stress assignment is postlexical; it applies after all morphological and phonological rules have applied (Fares, 1993).
vii. The interaction of the prosodic parameters (fundamental of frequency, intensity, duration) is a determining factor in stress placement (Boudlal, 2001).

The OT account has shown that stress in MA is governed by the following constraints ranking (Boudlal, 2001):

ALIGNHD-R >> WSP >>NONFIN >> FT-TYPE$_{IAMB}$>>Ft-BIN>> PARSE-σ >> Ft-TYPE$_{TROC}$

Stress in words, in context, shows that MA is an iambic foot type[2] and that $FTTYPE_{IAMB}$ (which is right-headed) is ranked above $FTTYPE_{TROC}$ (which is left-headed). Boudlal (2001) assumes that the basic stress pattern of MA is iambic and that trochaic feet exist in the language under certain conditions. Weight-to-Stress Principle (WSP) (Prince and Smolensky 1993), which requires a heavy syllable to be stressed in foot structure, has to be ranked above NON-FIN to ensure stress on the final heavy syllable in words such as [limun] "orange". Stress in MA is restrictively located in one of the last two. In OT terms, this is regulated by Alignment Theory, namely the constraint ALIGNHD-R wherein the right edge of the prominent foot (Ft') must be aligned with the right edge of the PWd. ALIGNHD-R has to outrank WSP thus dominates NON-FIN by transitivity to exclude forms such as [*(Sán)(Da.la)]. The coming discussion will exemplify and further the conflict relation between the constraints.

2.4.2. Stress in English

Stress in English is regulated by the following constraint ranking (Hammond, 1999).

$$\text{Ft-TYPE}_{TROC} >> \text{NONFIN} >> \text{WSP} >> \text{Ft-BIN, ALIGNHD-R} >> \text{PARSE-}\sigma >> \text{FT-TYPE}_{IAMB}$$

While this hierarchy does not account for every token in English, it provides the overall generalizations of stress patterns in English, particularly in monomorphemic words. These generalizations include:

i. ALIGNHD-R and Ft-TYPE_{TROC} are undominated in English.
   a) Ft-TYPE_{TROC} must dominate Ft-TYPE_{IAMB} so that feet can be left-headed; stress falls on the left edge of the foot. *A(**me**ri)ca* is more harmonic than *A(me**ri**)ca*.

ii. The remaining constraints are dominated. They are also in conflict with each other, and hence some of them are ranked relative to each other:
   a) WSP should outrank NONFIN so that words ending in a heavy syllable can carry stress; *a(**gree**)* and *a(**larm**)* are more harmonic than*(**a**)gree* and *(**a**)larm*.
   b) NONFIN must outrank Ft-BIN; A *(meri)ca* is a more harmonic parse than *(Ame)(rica)*.
   c) WSP must dominate Ft-BIN so that a heavy syllable can be stressed; *a(gen)da* is a better parse than *(agen)da*.
   d) Ft-BIN must dominate PARSE-σ. The parse *A(meri)ca* is more harmonic than *(A)(meri)ca* or *(Ame)(ri)ca*.

Recall that these constraints are universal; shared in all languages. In stress learnability, learners are supposed to learn the above constraints hierarchy, i.e., they have to rerank the constraints making use of CDA.

2.4.3. English Stress versus MA Stress: Additional Remarks

Stress patterns of MA and English share some similarities in terms of position. Stress is not fixed to a certain position within a word but realized within three final syllables: final stress position (e.g., MA li'mun "orange"; English prɪ'zent), penultimate syllable (e.g., San'DaLa "sandal"; ə'dʒendə), and antepenultimate syllable (e.g., 'mænɪdʒmənt; 'fʕajəlkum "your (pl.) deeds"). Stress assignment in English invokes three types of information: (i) syntactic information (whether the word is a noun, an adjective, a verb, etc., e.g., 'increase (N) vs in'crease (V)), morphological structure (whether the word is mono- or polymorphemic, e.g., límit vs limitátion), and phonological information (e.g., whether a syllable is light or heavy).

MA and English stress systems share some regularities, i.e., the morphological structure of the constituents, their rhythmic organization, intrinsic prominence of the syllable (weight), and the number and position of the syllables in a word. However, they differ in terms of stress function, stress position, stress degrees, and vowel reduction. As for the function of stress, whereas stress is phonetic (i.e., predictable) in MA, it is phonemic in English. In English, stress distinguishes compound nouns from adjectives followed by nouns (**black**board vs black **board**)[3], alternates meaning (**con**tent vs con**tent**), and differentiates word class (e.g., **pre**sent vs pre**sent**). As opposed to MA, where there is only one level of stress, English distinguishes four degrees of stress: primary (1ry), secondary (2ry), tertiary (3ry) and zero (0) stress (unstressed). As for vowel reduction, in English, the vowels that occupy the nucleus of unstressed syllables are reduced to a schwa. In MA, on the other hand, unstressed vowels are always realized in full forms.

[2] Recall that, according to Boudlal (2001), there are two possible analyses in terms of foot structure in MA: (i) **trochaic foot** that is attested in words in isolation; and (ii) **iambic foot** which is observed in words in context. This paper adopts the view that $FTTYPE_{IAMB}$ outranks $FTTYPE_{TROC}$. OT allows both iambs and trochees in the same language; and it is the interaction with other higher ranked constraints that decides which one to appear. Further support of this fact is found in McCarthy and Prince (1993a, p. 150) who show that the stress pattern of Axininca Campa, an Arawakan language of Peru, is both iambic and trochaic.

[3] Bold indicates the stressed syllable.

3. Method

3.1. Research problem

This study attempts to address the problem of word-stress errors among Moroccan Learners of English. There is a consensus among some educators that Moroccan learners' speech is Moroccan Arabic-like. Since stress placement can alter meaning as instantiated earlier, stress errors can precipitate false recognition, which can yield communication breakdown. Since "pronunciation is the most challenging aspect of mastering a foreign language" (Alaoui et al., 2004/2019), making errors calls for further research in this area. Therefore, it is intriguing and necessary to conduct a study that investigates this type of error, traces back the learning stages within the framework of OT, and provides some pedagogical implementation.

3.2. Research questions

The present study enquires the following research questions. While question one generates quantitative data, questions two and three generate qualitative data.

1. Are there any common error patterns that consistently cause difficulty for Moroccan learners?
2. How does learners' L1 constraint ranking affect their acquisition of English word-stress?
3. Employing CDA, how do Moroccan learners acquire English word-stress?

3.3. Participants

A total of sixty students at the university participated in this study. The subjects under investigation are Third-Year University (TYU). To ensure the homogeneity of the samples under investigation, the participants filled in a personal information section in the test that assured that they all had the same linguistic background. Thus, all participants speak MA as their mother tongue and have similar formal exposure to the English language. To ensure that the participants have similar proficiency in English stress, they were also administered an oral multiple-choice test that elicited their intuition about English stress patterns.

3.4. Research design

This study is explanatory in nature as it aims to explain the causes/sources and consequences of a research problem. We believe that this type of research is appropriate for this study. It is a method developed to investigate a research problem that is understudied or has not been well explained previously. Its main intention is to explain the problem of word stress misplacement among Moroccan learners of English. It provides an in-depth explanation of learners' errors in word stressing and tracks down the stages (from the initial stage to the final one) of stress acquisition employing CDA.

This study adopted a mixed research design that collects, analyses, and "mixes" both quantitative and qualitative research and methods in a single study. Our choice of a mixed-method design can be seen in the following lines. One type of research is not enough to answer the present research questions. For example, answering the first research question requires a quantitative method, whereas answering the second and third research questions implicates a qualitative method. Also, both quantitative (numerical) and qualitative (nominal) data collection methods were adopted because two data collection instruments had been recruited: an oral test and a systematic observation.

In short, the explanatory sequential mixed methods design is characterised by three stages. In the first stage, we collected and analysed the quantitative data. In the second stage, the researcher collected and analysed the qualitative data. In the last stage, the researcher integrated and linked the data collected in the first and second stages. The intent of using this design is to bring together the different strengths of both methods and to better explain the quantitative results. There are three main reasons for adopting a mixed research design. First, through the explanatory research design, the researcher intends to determine the factors that seem to be associated with the participants' stress errors, such as the linguistic environments and the sources of these errors. Investigating these variables is significant to understanding learners' phonological errors from a holistic viewpoint. Second, a mixed research design choice is justified by the nature of the research questions, which target both qualitative and quantitative data. Finally, it is a method that allows the researcher to avoid misleading interpretations and making unreliable judgments if only a single-method design is adopted.

3.5. Instrument and procedure

To answer the research questions, a corpus of relevant data needs to be collected through relevant instruments. This study has opted for two data collection instruments: oral multiple-choice questions (MCQ) and observation. An oral MCQ test was used to select homogeneous participants and to generate data about stress development. The rationale behind this particular test lies in fostering the authenticity of the data. This instrument can generate more spontaneous production of the targeted item (word-stress) as participants' focus is on the meaning of the words rather than the accurate pronunciation, yielding more random data. The test consists of two sections: the first section is concerned with personal information, while the second section generates students' intuition about English stress patterns. The test includes a corpus of 80 items. At first, ninety-three participants sat for

the test. Eighty participants whose score was between 8 and 11 out of 20 were selected. The test was administered orally; learners read loudly their answers while being recorded for later analysis.

They were required to articulate a list of 80 English discrete words. Later, their utterances were coded and converted into statistical analysis to determine if they made consistent errors. In addition to error frequency, the researcher used some erroneous instances to discuss and explain these errors within the framework adopted in this study (OT). The data drawn from the test was collected by means of recording the sample's articulation of the English stress that was given to the subjects in different linguistic contexts (disyllabic, trisyllabic, and polysyllabic.). They were recorded while they were taking turns articulating the list of English words.

Observation is an effective instrument for collecting data so as to understand a certain phenomenon in its natural setting. In the present study, we opted for systematic non-participant observation to survey or measure the sample's acquisition of stress without trying to affect them. By this data collection method, we could gather information about stress learnability by observing this phenomenon as it occurs. The observation is employed mainly to generate frequency data. Such data "show how often a variable is present in the data" (Hatch & Lazaraton, 1991, p. 62). In the present research, the observation enables the researcher to generate the frequency of stress error occurrence.

The checklist consists of eight five-point statements (starting from *always* up to *never*). Most of these statements mainly targeted the frequency of occurrence of the stress misplacement according to phonological knowledge (the type of syllable: disyllabic, trisyllabic, and polysyllabic), syntactic knowledge (the part of speech), and morphological knowledge when morphemes are added that may result in stress shift (e.g., ˈθiːətər "theatre" versus θɪˈætrɪkəl "theatrical"). The observation of stress errors lasted for five sessions, and the frequency of their occurrence was assessed using a scale so that the data collected could be easily counted and converted into statistics. The scale involves numbers: (0) never, (1) seldom, (2) often, (3) sometimes, and (4) always. In order to code the data obtained from observation, the researcher used the following scale: the item with the means of between (0 - 0.99), (1.00 - 1.99), (2.00- 2.99), (3.00 – 3.99), or (4.00 - 5.00) is rated never, seldom, often, sometimes, or always, respectively. The researcher managed to carry out the observation without trying to affect learners' behaviour or letting them notice that they are being observed. The observation is appropriate in this research, for it assessed the validity and reliability of data collected from the other two employed instruments. It follows that the sample, when being observed, could not change their behaviour, for they did not know that they were being studied. By employing observation, we obtained actual data in its natural setting.

After collecting data from the sample, the research data was analysed using different qualitative and quantitative techniques. The data was analysed using frequencies and percentages to allow the researcher to categorise stress errors in various linguistic contexts. Central to the present study is to account for stress acquisition among Moroccan learners of English within the principles of OT. Thus, the qualitative data is also presented and discussed by means of tableaux which accounts for the optimality and grammaticality of stress assignment. Tableaux have also provided data to account for the stages of stress acquisition and show the role of UG in second language acquisition.

4. Data presentation

4.1. Presentation of the test results

This section attempts to offer a triangulated presentation of the quantitative and qualitative results of the test. Note that, at first, the data of the test were qualitatively analysed to allow the researcher to categorise the errors. The quantitative and qualitative results will be tabularised simultaneously: each context of errors, along with its frequency, will be concurrently demonstrated in an attached table using crosstabulation. This section primarily aims to provide a presentation of the frequency distribution of the stress errors made by the participants in each linguistic environment. These linguistic environments include disyllabic words, trisyllabic words, polysyllabic words, and compound words. Consider table 1.

Table 1: *The frequency distribution of the participants' stress errors in the test*

		Items	The participants' utterances	Errors' frequency	Errors' percentage
Disyllabic words	Disyllabic verbs	embrace	/ɪmˈbreɪs/	63	78.7%
			*/ˈɪm.breɪs/	17	21.2%
		admit	/ədˈmɪt/	60	75.0%
			*/ˈəd.mɪt/	20	25.0%
		answer	/ˈɑːn.sər/	43	53.7%
			*/ɑːnˈsər/	37	46.2%
		summon	*/sʌ.ˈmon/	34	42.5%
			/ˈsʌm.ən/	46	57.5%

	Disyllabic nouns	centre	/ˈsen.tər/	58	72.5%
			*/sən.ˈter/	22	27.5%
		scissors	/ˈsɪz.əz/	57	71.2%
			*/sɪ.ˈzuz/	23	28.7%
		extreme	/ɪkˈstriːm/	47	58.7%
			*/ˈɪk.striːm/	33	41.2%
		machine	*/ˈmɑ.ʃiːn/	32	40.4%
			/məˈʃiːn/	48	60.0%
	Disyllabic adjectives	hollow	/ˈhɑːˑloʊ/	59	73.7%
			*/hɑːˈloʊ/	21	26.2%
		polite	/pəˈlaɪt/	43	53.7%
			*/ˈpo.laɪt/	37	46.2%
		fatal	/ˈfeɪ.təl/	51	63.7%
			*/faˈtæl/	29	36.2%
		discrete	/dɪˈskriːt/	49	61.2%
			*/ˈdɪ.skriːt/	31	38.7%
Trisyllabic words	trisyllabic verbs	imagine	/ɪˈmædʒ.ɪn/	42	51.2%
			*/ɪ.mæˈdʒɪn/	35	26.3%
			*/ˈɪ.mædʒ.ɪn/	3	22.5%
		resurrect	*/ˌrez.ˈər.ekt/	13	28.7%
			/ˌrez.ərˈekt/	57	38.7%
			*/ˌreˈzʌr. əkt/	10	22.5%
		determine	*/dɪ.təˈmɪn/	8	13.7%
			/dɪˈtɜːr.mɪn/	47	46.2%
			*/dɪ.tɜːrˈmɪn/	25	40.1%
		develop	*/ˈdɪ.vel.əp/	9	11.2%
			/dɪˈvel.əp/	42	52.5%
			*/dɪ.veˈlop/	29	26.3%
		entertain	*/enˈtər.teɪn/	13	35.0%
			*/ˈen.tər.teɪn/	6	10.0%
			/en.təˈteɪn/	61	55.0%
	Trisyllabic nouns	intestine	/ɪnˈtes.tɪn/	64	80.0%
			*/ɪn.te.səˈtɪn/	7	8.7%
			*/ɪn.təsˈtɪn/	9	11.2%
		citizen	/ˈsɪt.ɪ.zən/	47	58.7%
			*/sɪˈtɪz.ən/	21	26.2%
			*/sɪ.ˈtɪ.zən/	12	15.0%
		appendix	/əˈpen.dɪks/	62	77.5%
			*/ə.ˈpen.dəks/	10	12.5%
			*/ə.pənˈdɪks/	8	10.0%
		paragraph	/ˈpær.ə.grɑːf/	44	55.0%
			*/pəˈræg.rɑːf/	17	21.2%
			*/pær.əˈgrɑːf/	19	23.7%
	trisyllabic adjectives	insolent	/ˈɪn.səl.ənt/	55	68.7%
			*/ɪn. səˈlent/	14	17.5%
			*/ɪn.ˈsul.ənt/	11	13.7%
		positive	/ˈpɒz.ə.tɪv/	41	51.2%
			*/pɒz.ə.ˈtɪv/	18	22.5%
			*/pɒ.ˈzɪ.tɪv/	21	26.2%
		shimmering	/ˈʃɪm.ər.ɪŋ/	57	71.2%
			*/ʃɪˈmer.ɪŋ/	10	15.5%
			*/ʃɪm.əˈrɪŋ/	13	16.2%

		decisive	/dɪˈsaɪ.sɪv/	42	52.5%
			*/ˈdɪ.saɪ.sɪv/	3	3.7%
			*/dɪ.saɪˈsɪv/	15	18.7%
			*/dɪ.sɪˈsɪv/	18	22.5%
			*/ˈdɪ.sɪ.sɪv/	2	2.5%
Polysyllabic words	Polysyllabic verbs	exaggerate	/ɪgˈzædʒ.ə.reɪt/	51	63.7%
			*/ɪg.zdʒ.əˈ.reɪt/	17	21.2%
			*/ɪg.zaˈ.dʒu.reɪt/	12	15.0%
		assimilate	/əˈsɪm.ɪ.leɪt/	54	67.5%
			*/ə.sɪm.ɪˈleɪt/	16	20.0%
			*/ə.sɪˈmɪ.leɪt/	10	12.5%
		communicate	/kəˈmjuː.nɪ.keɪt/	48	60.0%
			*/kə.mjuː.nɪ.ˈkeɪt/	21	26.2%
			*/kə.mjuːˈnɪ.keɪt/	11	13.7%
		reconsider	/riː.kənˈsɪd.ər/	41	51.2%
			*/riːˈkon.sɪd.ər/	27	33.7%
			*/riː.kən.ˈsaɪd.ər/	12	15.0%
	Polysyllabic nouns	democracy	/dɪˈmɒk.rə.si/	57	71.2%
			*/dɪ.mɒˈkra.si/	23	28.7%
		communication	/kəˌmjuː.nɪˈkeɪ.ʃən/	45	78.7%
			*/kəˈmjuː.nɪ.keɪ.ʃən/	9	11.2%
			*/kə.mjuːˈnɪ.keɪ.ʃən/	26	10.0%
		intelligence	/ɪnˈtel.ɪ.dʒəns/	58	72.5%
			*/ɪn.teˈlɪd.ʒəns/	22	27.5%
		terminology	/ˌtɜː.mɪˈnɒl.ə.dʒi/	61	76.2%
			*/ˈtɜː.mɪ.nɒl.ə.dʒi/	1	1.2%
			*/ˌtɜː.mɪ.nɒl.əˈ.dʒi/	10	12.5%
			*/ˌtɜː.mɪ.nɒˈlɒ.dʒi/	6	7.5%
			*/ˌtɜːˈmɪn.ɒl.ə.dʒi/	2	2.5%
	Polysyllabic adjectives	phonological	/ˌfɒn.əˈlɒdʒ.ɪ.kəl/	59	73.7%
			*/ˈfɒn.ə.lɒdʒ.ɪ.kəl/	4	5.0%
			*/fɒˈnɒ.lɒdʒ.ɪ.kəl/	2	2.5%
			*/ˌfɒn.ə.lɒˈdʒɪ.kəl/	15	18.7%
		economic	/ˌiː.kəˈnɒm.ɪk/	46	57.5%
			*/iː.ˈkɒː.nɒ.mɪk/	13	16.2%
			*/iː.kɒː.nəˈ.mɪk/	21	26.2%
		incredible	/ɪnˈkred.ə.bəl/	51	63.7%
			*/ɪn.kreˈ.dɪ.bəl/	29	36.2%
		conservative	/kənˈsɜː.və.tɪv/	52	65.0%
			*/kən.səˈveɪ.tɪv/	28	35.0%
compound words	compound verbs	waterproof	/ˈwɔː.tə.pruːf/	47	58.7%
			*/wɔː.təˈpruːf/	33	41.2%
		skydive	/ˈskaɪ.daɪ/	45	56.2%
			*/skaɪˈdaɪ/	35	43.7%
		brainwash	/ˈbreɪn.wɒʃ/	50	62.5%
			*/ˈbreɪnˈwɒʃ/	30	37.5%
		outrun	/aʊtˈrʌn/	63	78.7%
			*/ˈaʊt.rʌn/	17	21.2%
	compound nouns	wristwatch	/ˈrɪst.wɒtʃ/	60	75.0%
			*/rɪst.ˈwɒtʃ/	20	25.0%
		lemon-juice	/ˈlem.ən dʒuːs/	49	61.2%
			*/lem.ən ˈdʒuːs/	31	38.7%

	pancake	/ˈpæn.keɪk/	51	63.7%
		*/ˈpænˈkeɪk/	29	36.2%
	rosewater	/ˈrəʊz wɔː.tər/	52	65.0%
		*/rəʊz ˈwɔː.tər/	28	35.0%
	chicken-bouillon	/tʃɪk.ɪn ˈbuː.jɑn/	44	55.0%
		*/ˈtʃɪk.ɪn buː.jɑn/	36	45.0%
	apple pie	/ˌæp.əl ˈpaɪ/	46	57.5%
		*/ˈæp.əl paɪ/	34	42.5%
	beef-stew	/biːf ˈstjuː/	47	58.7%
		*ˈbiːf stjuː/	33	41.2%
compound adjectives	homesick	/ˈhəʊm.sɪk/	43	53.7%
		*/ˈhəʊmˈsɪk/	37	46.2%
	laboursaving	/ˈleɪ.bə.seɪ.vɪŋ/	46	57.5%
		*/leɪ.bəˈlseɪ.vɪŋ/	34	42.5%
	sunbaked	/ˈsʌn.beɪkt/	47	58.7%
		*/sʌnˈbeɪkt/	33	41.2%
	strong-willed	/strɒŋˈwɪld/	54	67.5%
		*/ˈstrɒŋ.wɪld/	26	32.5%

Table 1 clearly instantiates that Moroccan learners in this study encountered great difficulty in stressing English words. In stress on disyllabic verbs, the two highest frequencies of errors are in misplacing stress in words (which do not receive stress on the ultimate syllable, unlike other items) *answer* and *summon* with 37 and 34, respectively. In disyllabic nouns, items such as *extreme* (F.33) and *machine* (F.32) compromised more difficulty for the participants. These consistent errors are due to the inconsistency of stress patterns in English. While disyllabic nouns in English mostly attract penultimate stress, the final syllable is stressed if it is heavy. One strategy used by the participants to overcome this difficulty is to overgeneralise the overall pattern by placing stress on the penultimate syllable without making recourse to syllable weight. Similar to the stress pattern on verbs and nouns, we notice that the participants made recourse to syllable position rather than syllable weight. They made more errors in the items with ultimate syllables: *polite* (F.37) and *discrete* (F.31).

As for trisyllabic words, the table displays that the highest frequency of errors is the category of words whose both penult and ultimate syllables are heavy such as *determine* (F. 33: */dɪ.tɜːrˈmɪn/ 'F. 25' and */dɪ.tərˈmɪn/ 'F. 8') and words wherein students failed to parse the two final syllables correctly such as *imagine* (F. 38: */ɪ.mæˈdʒɪn/ 'F.35' and */ˈɪ.mædʒ.ɪn/ 'F.5') and *develop* (F. 38: */dɪ.veˈlop/ 'F.29' and */ˈdɪ.vel.əp/ 'F.9'). Parsing these words as *i.ma.gine and *de.ve.lop compels ultimate stress as it generally falls on the ultimate syllable if it is heavy (e.g., /en.tərˈteɪn/ and /ˌrez.ərˈekt/) otherwise on the penultimate syllable (e.g., /ɪˈmædʒ.ɪn/, /dɪˈvel.əp/, /əkˈnɒl.ɪdʒ/, and /əˈbæn.dən/).

This implies that the students might be aware of the role of syllable heaviness in determining stress. However, they made errors either due to misparsing the words, as in */ɪ.mæˈdʒɪn/, */ək.nɒˈlɪdʒ/ or mispronouncing the nucleus vowel. As can be observed, the vowel of the penultimate syllable in the word /dɪˈtɜːr.mɪn/ was weakened to a schwa as */dɪ.tərˈmɪn/, hence it lost the potential of attracting stress. In the word /dɪˈvel.əp/ and /ˌrez.ərˈekt/, the weak vowel was strengthened as */dɪ.veˈlop/ and */ˌreˈzʌr.ekt/, which resulted in triggering stress. Thus, the mispronunciation of the vowel sound influences stress placement. Making such errors (e.g., */ək.nɑːˈlɪdʒ/) implies that the participants relied on the syllable weight to assign stress. Also, errors such as */ˈen.tər.teɪn/ indicates that learners perhaps relied on the morphological information in assigning stress. By analogy, they incorrectly placed stress on the antepenultimate syllable (*/ˈen.tər.teɪn/); perhaps the verb *entertain* was regarded as attaching the morpheme *+tain* to the verb *enter* (enter+tain), where en is stressed (/ˈen.tər/).

Table 1 reveals that the most challenging trisyllabic nouns for the participants are the items that receive antepenultimate stress: *paragraph* (F. 36) and *citizen* (F. 33). In trisyllabic nouns, stress falls on the penultimate (e.g., /ɪnˈtes.tɪn/) syllable if it is heavy, otherwise on the antepenultimate (e.g., /ˈpær.ə.grɑːf /). In English trisyllabic nouns, the final syllable is treated extrametrical (i.e., it is ignored for determining stress). However, some students relied on syllable weight and hence stressed the final syllable if it is heavy (applying the stress pattern of disyllabic nouns) as */ɪn.tes.ˈtɪn/, */ə.penˈdɪks/, and */pær.əˈgrɑːf/. By the same token, some students mispronounce vowels which results in shifting the place of stress. Some examples from Table 1 are */ə.pənˈdɪks/ and */ɪn.təsˈtɪn/, where the nucleus (/e/) of the penultimate syllable was reduced into a schwa and hence lost its stressability. Parsing the items /ˈpær.ə.grɑːf/ and /ˈsɪt.ɪ.zən/ as */pəˈræg.rɑːf/ and */sɪˈtɪz.ən/, respectively, yielded a stress shift as the syllable in questions had become light.

As for trisyllabic adjectives, the highest frequency of errors is in stressing the words *positive* (F. 39: */pɒ.ˈzɪ.tɪv/, F.21 and */pɒz.əˈ.tɪv/, F.18) and *decisive* (F. 38: */dɪ.sɪˈsɪv/, F. 18; */ˈdɪ.sɪ.sɪv/, F.2; */dɪ.saɪˈsɪv/, F.15; and */ˈdɪ.saɪ.sɪv/, F. 3). In addition to not placing stress on the correct syllable (yet all segments are pronounced correctly), some students misplaced stress either due to mispronouncing the vowel (e.g., */dɪ.sɪˈsɪv/) or incorrect parsing of the syllable (e.g., */pɒ.ˈzɪ.tɪv/).

From Table 1, it is evident that verbs such as *reconsider* (F.39) which require penultimate stress, are the most challenging polysyllabic verbs for learners. The errors made by the participants showed that they adhered to the English stress pattern on polysyllabic verbs. In English polysyllabic verbs, stress falls on the antepenultimate syllable, but it falls on the penultimate syllable if it is heavy. With this in mind, the participants made recourse to making the antepenultimate syllable heavy to trigger stress, as in */riːˈkon.sɪd.ər/, or making it light and making the penultimate syllable heavy such as */ɪg.zaˈ.dʒu.reɪt/ to attract stress. Also, errors such as */riːˈkon.sɪd.ər/ imply that the participants overgeneralised the rule of stressing the antepenultimate syllable regardless of considering the weight of the penultimate syllable.

The polysyllabic noun *communication* scores the highest frequency (F.35) of errors among the participants. Such a word is challenging because it receives penultimate stress, while most polysyllabic nouns are often stressed on the antepenultimate (but on the penultimate syllable if it is heavy). Besides, the stressed syllable in its verb form (/kəˈmjuː.nɪ.keɪt/) becomes invisible for the primary stress domain in the noun-verb. Perhaps due to overgeneralization, the participants assigned incorrect stress to the same stressed syllable (*/kəˈmjuː.nɪ.keɪ.ʃən/) in the verb form (i.e., /kəˈmjuː.nɪ.keɪt/≃ /kəˌmjuː.nɪˈkeɪ.ʃən/).

Across the polysyllabic adjectives, it is clear that the participants found it not very difficult to produce the adjectives which receive antepenultimate stress while they faced challenges stressing the polysyllabic adjectives that attract penultimate stress. One example is displayed in Table 1, wherein the adjective *economic* with penultimate stress scores the highest frequency of errors (F.34). While the participants erred due to vowel mispronunciation in errors such as */iːˈ.kɒː.nəm.ɪk/ and */kən.səˈveɪ.tɪv/, they misplaced stress because of wrong syllable parsing in errors such as */ɪn.kre.ˈdɪ.bəl/.

The data analysis revealed that the participants encountered some challenges in producing compound words. From the table, the participants seem to have had more difficulty in producing compound verbs whose first element is a noun. These verbs have reported the highest frequency: *skydive* (F.35), *waterproof* (F.33), and *brainwash* (F.30). Such words constitute the exception to the general rule. Compound verbs receive stress on the second element (e.g., /aʊtˈrʌn/, /əʊ.vəˈfləʊ/, /bækˈdeɪt/, etc.) except the verbs whose first element is a noun as in /ˈwɔː.tə.pruːf/, /ˈbreɪn.wɒʃ/, and /ˈskaɪ.daɪ/. The participants incorrectly overgeneralised the rule resulting in the ill-formed utterances: */skaɪˈdaɪ/, */wɔː.təˈpruːf/, */breɪnˈwɒʃ/.

The general rule of stress pattern in English compound nouns is that primary stress falls on the first element as in /ˈrɪst.wɒtʃ/, /ˈgəʊld.fɪʃ/, /ˈswɪm.ɪŋ puːl/, /ˈheə.brʌʃ/, /ˈheə.brʌʃ/, and /ˈbriːf.keɪs/. From the table, the participants seem to have less difficulty in applying the general stress pattern in compound nouns. We can instantiate that the compound nouns whose first element is an ingredient of the second element were challenging for the participants. Some examples of these nouns are *chicken-bouillon* (F.36), *apple pie* (F.34), and *beef-stew* (F.33). Unlike the general rule, in these nouns, primary stress falls on the second element. However, the compound nouns *lemon-juice*, *pancake*, and *rosewater* (with a frequency of 31, 29, and 28, respectively) caused more difficulty for the participants because they are exceptions. Although their first element is an ingredient of the second element, the compound nouns ending in juice (e.g., lemon juice), cake (e.g., pancake), or water (e.g., rosewater) have primary stress on the first element. The participants incorrectly overgeneralise the rule, which resulted in the ill-formed utterances: */lem.ən ˈdʒuːs/, */pænˈkeɪk/, and */rəʊz ˈwɔː.tər/.

Alike compound verbs, compound adjectives whose first element is a noun seem to have caused more difficulty for the participants. As observed in the table, these adjectives reported the highest frequency: *homesick* (F.37), *laboursaving* (F.34), and *sunbaked* (F.33). In compound adjectives, stress falls on the second element such as *fat-free*, *strong-willed*, *quick-witted*, etc., but not on the first element if it is a noun (e.g. /ˈleɪ.bə.seɪ.vɪŋ/).

To categorise the participants' errors according to the position of the syllable, consider Table 2 below. It illustrates the words presented to the participants along with the percentage of stress errors labelled into the position of the syllable: antepenultimate, penultimate, or ultimate. Some of these words will be further explained in reference to CDA in due course.

Table 2: *Errors according to the position of the syllable*

	Disyllabic	Trisyllabic	Polysyllabic
Antepenultimate		ˈAgenda (13%) ˈOctober (39%)	ˈAcademic (46%)
Penultimate	ˈGarage (11%) ˈCommence (10%) ˈJuly (70%) ˈDirect (43%)	ciˈgarette (67%) OˈrigIn (43%) MiˈnIster (61%) InˈfluEnce (46%)	AmeˈrIca (52%) CereˈmOny (56%) NeceˈssAry (68%) ElectriˈcIty (49%)
Ultimate	CoˈffEe (47%) AttˈIc (52%) ObˈjEct (61%) CliˈmAte (44%)	SatelˈlIte (63%) AniˈmAl (41%) DeterˈmIne (38%) FantasˈtIc (46%)	AmeriˈcA (16%) ExcommuniˈcAte (71%)

In words in Table 2, 3 out of 24 receive antepenultimate stress, i.e., about 4%, 12 out of 24 receive penultimate stress, i.e., 50%, and 10 out of 24 receive ultimate stress, i.e., about 46%. It is evident that most of the stress errors are restrictively located to the last two syllables, a state of affairs which can be explained by the participants' L1 stress pattern that locates stress on the ultimate syllable if it is heavy, otherwise on the penultimate. One remark that could be made about the results in the table above is that the participants did not hesitate to stress the heavy syllable. This fact can be attributed to L1 transfer wherein heavy syllable triggers stress.

4.2. Presentation of the observation results

To supplement the test results, the observation was mainly used as support in the study by collecting data to understand the acquisition of English stress in its natural setting without trying to affect the participants. The checklist consists of eight five-point statements (starting from *always* up to *never*). To code the data obtained from observation, the researcher used the following scale: the item with the means of between (0 - 0.99), (1.00 - 1.99), (2.00- 2.99), (3.00 – 3.99), or (4.00 - 5.00) is rated never, seldom, often, sometimes, or always, respectively. Table 3 below illustrates the frequency of the stress errors occurrence for each item.

Table 31: *The results of the Likert scale on the stress errors' occurrence*

				Frequency of occurrence				
		M	SD	Always (4.00 - 5.00) Count	Often (3.00 – 3.99) Count	Sometimes (2.00- 2.99) Count	Seldom (1.00 - 1.99) Count	never (0 - 0.99) Count
items	1. Students use correct stress on words and word groups.	2.03	1.01			✓		
	2. Students clearly contrast between stressed and unstressed syllables.	3.27	1.56		✓			
	3. Students assign stress correctly to disyllabic words.	3.34	1.62		✓			
	4. Students assign stress correctly on Trisyllabic words.	2.83	1.22			✓		
	5. Students assign stress correctly to polysyllabic words.	3.61	1.69		✓			
	6. Students make a difference between stress on nouns and verbs	2.06	1.03			✓		
	7. Students make a difference between stress on adjectives and verbs.	3.89	1.81		✓			
	8. Students make mistakes on stress when it changes the meaning.	2.94	1.25			✓		

The observation results demonstrated in Table 3 supported the results obtained from the test tool. The overall results reveal that the

problem of stress misplacement is recurrent among the participants in different linguistic environments. Table 3 shows that the results vary between two scale responses, namely (often) and (sometimes).

The observation revealed some situations when a word, especially a word critical to the understanding of the message, cannot be recognised; listeners stopped all other processing to decode the word that was not understood. For example, the word *gopher* (/ˈgəʊ.fər/) was incorrectly produced as /gəʊ.ˈfɔːr/, /gəʊ.fər/, and /gəʊ.fɔːr/; thus, it was misinterpreted as *go for*. However, for some words, such as the noun permit (/ˈpɜː.mɪt/), when mispronounced as /pərˈmɪt/ (verb form), misplacing stress did not affect intelligibility. In Table 4, we offer some examples of stress errors that were gathered by means of observation.

Table 4: *Observation results in the Frequency of errors in different linguistic environments*

		Items	error	errors frequency	total of errors within words
Disyllabic words	Disyllabic verbs	Retain (rɪˈteɪn/)	/rɪ.teɪn/	7	17
			/ˈrɪt.ən/	10	
		Transcribe (/meɪnˈteɪn/)	/meɪn.teɪn/	5	11
			/ˈmeɪn.tən/	6	
		Transcribe (/trænˈskraɪb/)	/træn.skraɪb/	5	10
			/ˈtræn.skraɪb/	5	
		Conjure (/ˈkʌn.dʒər/)	/kʌn.dʒər/	5	12
			/kən.ˈdʒur/	7	
	Disyllabic nouns	Effort (/ˈef.ərt/)	/ef.ərt/	5	13
			/eˈfɒrt/	8	
		Prefix (/ˈpriː.fɪks/)	/priː.fɪks	3	10
			/priˈfɪks/	7	
		Insight (/ˈɪn.saɪt/)	/ɪn.saɪt/	3	14
			/ɪnˈsaɪt/	11	
		Gopher (/ˈgəʊ.fər/)	/gəʊ.fər/	2	6
			/gəʊ.fɔːr/	4	
	Disyllabic adjectives	Vibrant (/ˈvaɪ.brənt/)	/vaɪ.brənt/	2	10
			/vaɪˈbrant/	8	
		Unclear (/ʌnˈklɪər/)	/ʌn.klɪər/	3	11
			/ˈʌn.klɪər/	8	
		Unknown (/ʌnˈnəʊn/)	/ʌn.nəʊn/	3	8
			/ˈʌn.nəʊn/	5	
		Trusty (/ˈtrʌs.ti/)	/trʌs.ti/	4	12
			/trʌs.ˈti/	8	
Trisyllabic nouns	Trisyllabic verbs	Celebrate (/ˈsel.ə.breɪt/)	/sel.ə.breɪt/	3	5
			/seˈlɪb.reɪt/	2	
		Entertain (/en.tərˈteɪn/)	/ˈen.tər.teɪn/	2	4
			/en.ˈter.teɪn/	2	
	Trisyllabic nouns	Adjective (/ˈædʒ.ek.tɪv/)	/ædʒ.ek.tɪv/	5	11
			/əˈdʒek.tɪv/	6	
		Beginning (/bɪˈgɪn.ɪŋ/)	/bɪ.gɪn.ɪŋ/	4	10
			/ˈbɪ.gən.ɪŋ/	6	
	Trisyllabic adjectives	Interesting (/ˈɪn.trə.stɪŋ/)	/ɪn.trə.stɪŋ/	3	9
			/ɪn.ˈtrɪ.stɪŋ/	6	
		Possible (/ˈpɒs.ə.bəl/)	/pɒs.ə.bəl/	3	11
			/pɒ.ˈsɪb.əl/	9	
Polysyllabic nouns	Polysyllabic verbs	Familiarise (/fəˈmɪl·jəˌraɪz/)	/fə.mɪl.jə.raɪz/	1	5
			/fə.mɪl.jəˈraɪz/	4	
		Necessitate (/nəˈses.ɪ.teɪt/)	/nə.ses.ɪ.teɪt/	1	7
			/nə.seˈsɪ.teɪt/	6	

	Polysyllabic nouns	Pronunciation (/prəˌnʌn.siˈeɪ.ʃən/)	/prə.nʌn.si.eɪ.ʃən/	2	7
			/prəˈnʌn.si.eɪ.ʃən/	5	
		analysis (/əˈnæl.ə.sɪs/)	/ əˈnæ.lə.sɪs/	2	5
			*/ænæ'laɪ.sɪs/	3	
	Polysyllabic adjectives	Necessary (/ˈnes.ə.ser.i/)	/nes.ə.ser.i/	1	5
			/nes.əˈser.i/	4	
		Equivalent (/ɪˈkwɪv.əl.ənt/)	/ɪ.kwɪv.əl.ənt/	1	7
			/ɪ.kwɪˈval.ənt/	6	
Compound words	Compound verbs	Understand (/ˌʌn.dəˈstænd/)	/ʌn.də.stænd/	1	6
			/ˈʌn.də.stænd/	5	
		Outrun (/ˌaʊtˈrʌn/)	/aʊt.rʌn/	1	5
			/ˈaʊt.rʌn/	4	
	Compound nouns	Vocal-tract (/ˈvəʊ.kəl trækt/)	/vəʊ.kəl trækt/	5	14
			/vəʊ.kəlˈtrækt/	9	
		Forebear (/fɔː.beər/)	/fɔːr.beər/	2	9
			/fɔːrˈbeər/	7	
	Compound adjectives	Borderline (/ˈbɔː.də.laɪn/)	/bɔːr.də.laɪn/	2	6
			/bɔːr.dəˈlaɪn/	4	
		Blue-eyed (/ˌbluːˈaɪd/)	/bluː.aɪd/	2	7
			/ˈbluːaɪd/	5	
Word-class pairs	verbs	Record (/rɪˈkɔːrd/)	/rɪ.kɔːrd/	2	7
			/ˈrek.ɔːrd/	5	
		Convert (/kənˈvɜːrt/)	/kən.vɜːrt/	1	6
			/ˈkɒn.vɜːrt/	5	
	nouns	Permit (/ˈpɜːr.mɪt/)	/pɜːr.mɪt/	3	9
			/pərˈmɪt/	6	
		Progress (/ˈprəʊ.gres/)	/prəʊ.gres/	4	11
			/prəˈgres/	7	
Total		34	68	294	294

As shown in Table 4, the total number of stress errors is 294, which means that the participants are experiencing serious word stress problems. Similar to the results of the test, the results of the observation in Table 4 demonstrate some stress errors in word-class pairs. This may suggest that learners are not aware that each of these words can be pronounced differently according to the grammatical category of the item at hand (a verb or a noun/adjective). Another interesting result is the absence of stress in the majority of the items (e.g., suggest /sə.ʤest/). In a few cases, the participants produced words without any level of stress (in other words, with equal stress on each syllable). The overall results, indeed, supported the results obtained from the test, not only in terms of the stress error occurrence but also in consistent and systematic errors in different linguistic environments.

5. Analysis and discussion

The aim of this section is to develop an optimality-theoretic account for the results presented in the section above. Making use of the CDA, it attempts to track down the developmental stages of the learning process of word-stress. The problem that Moroccan learners encounter when learning the English stress system is foot typology. Recall that, unlike English, $FTTYPE_{IAMB}$ outranks $FTTYPE_{TROC}$ in words in context. Consider the example in tableau (4):

Ft-TYPE$_{IAMB}$: Align the head-syllable with its foot on the right edge (right-headed foot).
Ft-TYPE$_{TROC}$: Align the head-syllable with its foot on the left edge (left-headed foot).

(4) $FTTYPE_{IAMB}$ and $FTTYPE_{TROC}$ conflict in MA: /ʒaʒa/ (glass)

/ʒaʒa/	$FTTYPE_{IAMB}$	$FTTYPE_{TROC}$
a. ('ʒa.ʒa)	*!	
☞ b. (ʒa.'ʒa)		*

This tableau, which shows that *candidate b* is optimal as it satisfies the higher-ranking constraint, exhibits the domination relation of $FTTYPE_{IAMB}$ >> $FTTYPE_{TROC}$. It is established in the OT literature that the initial state of L2 acquisition matches the final state of

L1. In simpler terms, learners, when learning L2, start by establishing a random ranking that is exempt from the existing ranking (that of L1).

At the initial stage of acquisition, Moroccan learners fail to correctly place stress. By way of illustration, disyllabic words ssuch as the *attic*, *climate*, *object*, and *coffee* were mispronounced with stress on the ultimate syllable. By placing stress on the final syllable, learners try to satisfy FTTYPE$_{IAMB,}$ which dominates FTTYPE$_{IAMB}$ in their L1. Thus, learners transferred the incorrect ranking into their IL.

As an initial stage, applying the L1 ranking (in tableau 4) to the target language (TL, henceforth) word *coffee*, for example, yields the wrong output with ultimate stress. The results of the L1 transferred hierarchy are illustrated in tableau (5) below:

(5) Learners' initial state (IL): Transferred L1 hierarchy

/kɑːfi/	FT-TYPE$_{IAMB}$	FT-TYPE$_{TROC}$
a. (ˈkɑː.fi)	*!	
b. (kɑː.ˈfi)		*

The MA hierarchy favors the sub-optimal candidate (b), which is ruled out by the ranking of the TL. Candidate (a) surfaces as the (wrong) optimal output in the learners' IL as it satisfies FT-TYPE$_{IAMB}$. In the learners' IL, candidate (a) loses the competition due to the fatal violation of FT-TYPE$_{IAMB}$. Tableau (5) exemplifies how Moroccan learners transfer the wrong hierarchy of the L1 at the initial stages of acquisition.

Later, Moroccan learners, as language develops, show signs of optimizing their IL and hence corresponding to TL norms. Having negative evidence, the subsequent stage was to demote FT-TYPE$_{IAMB}$ step below FT-TYPE$_{TROC}$ by means of CDA, as shown in (6). FT-TYPE$_{TROC}$ is undominated in English, unlike in MA.

(6) Constraint (FT-TYPE$_{IAMB}$) demotion

/kɑːfi/	FT-TYPE$_{IAMB}$	FT-TYPE$_{TROC}$
a. (ˈkɑː.fi)	*!	
b. (kɑː.ˈfi)		*

The result of learners' demotion of the dominated constraint (the constraint violated by the optimal form) is illustrated in tableau (7):

(7) Learners' convergence into the English system

/kɑːfi/	FT-TYPE$_{TROC}$	FT-TYPE$_{IAMB}$
☞ a. (ˈkɑː.fi)		*
b. (kɑː.ˈfi)	*!	

The demotion of FT-TYPE$_{IAMB}$ below FT-TYPE$_{TROC}$ optimizes candidate (a) instead of candidate (b). Tableau (7) indicates that learners converge their IL into the English stress pattern, i.e., moving towards a constraint ordering that corresponds to the English hierarchy of word-stress location.

Now we turn to explain this state of affairs using a stratified hierarchy. As noted earlier, language learners start with an a priori assumption that at the initial stage, constraints are unranked relative to each other. Hence, constraints can be established in any order. However, with the principle of UG in mind, we modify this assumption and claim that the constraints, at the first stage, appear in the L1 hierarchy (ALIGNHD-R >> WSP >>NONFIN >> FT-TYPE$_{IAMB}$>>Ft-BIN>> PARSE-σ >> Ft-TYPE$_{TROC}$). Hence, the initial state of learning a language is the final state of the L1, as shown below:

(8)

Initial Stratum= {ALIGNHD-R, WSP, NONFIN, FT-TYPE$_{IAMB}$, Ft-BIN, PARSE-σ, Ft-TYPE$_{TROC}$}

The next step is to find out what dominates relative to the target grammar so as to optimize their IL. We assume that learners' developmental stages are explained by a trail-and-error process, in which they form hypotheses, err to prove them and make

corrections to optimize their grammar. By way of analogy, in OT terms, these processes are reflected in applying the L1 ranking, yielding the wrong output form, and demoting constraints to reach the most harmonic (correct) form.

The constraints violated by the optimal output are dominated by those violated by the suboptimal output; therefore, they have to be demoted to a lower stratum. Consider (9) where learners demote FT-TYPE$_{IAMB}$ to a lower stratum that is dominated by the initial stratum; the unavailability of lower stratum results in creating a stratum to house the demoted constraint.

(9)

Initial Stratum = {ALIGNHD-R, WSP, NONFIN, Ft-BIN, PARSE-σ, Ft-TYPE$_{TROC}$}

>>

Stratum 1 = {FT-TYPE$_{IAMB}$}

The domination relation in (10) is still not the final hierarchy. Different word structure compels learners to proceed with further demotion to improve the existing domination hierarchy. A constraint which is operative in stress location is WSP which is in conflict with NONFIN(ALITY). Consider tableau (11), which draws the domination hierarchy in learners' L1.

(10)

NON-FIN: No prosodic head is final in PrWd.
Weight-to-Stress Principle (WSP): A heavy syllable is stressed in foot structure.

(11) WSP and NONFIN conflict in MA: 'limun' (orange 'fruit")

/limun/	WSP	NONFIN
a. (ˈli. mun)	*!	
☞ b. (li.ˈmun)		*

Tableau (11) indicates that candidate (b) is the winner as it satisfies the higher ranked constraint (WSP) that mandates stress to fall on the heavy syllable. Candidate (a), on the other hand, is ruled out because it incurs a fatal violation of WSP. The ranking of these two constraints in learners' L1 is WSP>> NONFIN, while the opposite holds true for English (i.e., NONFIN dominates WSP). Hence, transferring the L1 hierarchy into the TL stress pattern yields the wrong output form. Tableau (12) below illustrates the IL after the L1 transfer.

(12) IL: Transferred L1 hierarchy

/sætəlaɪt/	FT-TYPE$_{TROC}$	WSP	NONFIN
a. sæ.(ˈtə.laɪt)		*!	*
b. (ˈsæ.tə) laɪt		*!	
c. (sæ)(tə.ˈlaɪt)	*!		*
💣 d. (sæ.tə)(ˈlaɪt)			*

The transferred ranking in this tableau favors the suboptimal candidate (d) (which is ruled out by the TL hierarchy) as it fares well in the higher ranked constraint. While candidates (a) and (b) are ruled out due to the violation of WSP, candidate (c) loses the competition because it fatally violates the high ranked constraint FT-TYPE$_{TROC}$.

At this stage, candidate (d) is considered optimal in learners' IL. Subsequently, learners come to realize that the transferred ranking fails to optimize the correct output form in English. This newly evidence impels a demotion of WSP below NONFIN to match the TL ranking, as shown in tableau (13).

(13) Constraint (WSP) demotion

/sætəlaɪt/	FT-TYPE$_{TROC}$	WSP	NONFIN
a. sæ.(ˈtə.laɪt)		*!	*
b. (ˈsæ.tə) laɪt		*!	
c. (sæ)(tə.ˈlaɪt)	*!		*
💣 d. (sæ.tə)(ˈlaɪt)			*

Tableau (13) above illustrates the process of the demotion of WSP because the accessed evidence showed that this constraint is dominated by NONFIN in English. The result of learners' demotion is illustrated in tableau (14):

(14) Learners' convergence into the English system

/sætəlaɪt/	FT-TYPE$_{TROC}$	NONFIN	WSP
a. sæ.(ˈtə.laɪt)		*!	*
☞ b. (ˈsæ.tə) laɪt			*
c. (sæ)(tə.ˈlaɪt)	*!	*	
d. (sæ.tə)(ˈlaɪt)		*!	

This tableau shows the convergence from IL into the English stress system by means of CDA. Candidate (b) is the optimal output because it best satisfies the high ranked constraints, and it only causes one minimal violation of WSP. Candidates (a) and (d) are similarly ruled out due to their violation of NONFIN. Candidate (c) loses the competition as it incurs a violation of the highest ranked constraint FT-TYPE$_{TROC}$. Indeed, the demotion of WSP optimizes the actual output in English. To illustrate this demotion in a stratified hierarchy, the constraint WSP has to be demoted to a lower stratum, as shown below:

(15)

Initial Stratum = {ALIGNHD-R, NONFIN, Ft-BIN, PARSE-σ, Ft-TYPE$_{TROC}$}

> >

Stratum 1 = {FT-TYPE$_{IAMB}$, WSP}

According to the stratified hierarchy in (15), while the constraint FT-TYPE$_{IAMB}$ and WSP are unranked with respect to each other (i.e., there is no domination relation between them), they are dominated by the initial stratum and all the constraints it houses. However, at this stage, this ranking needs further modification. It is well established that Ft-TYPE$_{TROC}$ does outrank FT-TYPE$_{IAMB}$ in English, unlike in MA. To ensure this ranking, learners have to house, by means of demotion, FT-TYPE$_{IAMB}$ in a stratum below WSP. Also, tableau (14) implies that NONFIN is dominated by t-TYPE$_{TROC}$; therefore, it should be demoted to a lower stratum that is dominated by the initial stratum. The constraints domination ranking in (15) is reformulated as (16) below:

(16)

Initial Stratum = {ALIGNHD-R, Ft-BIN, PARSE-σ, Ft-TYPE$_{TROC}$}

> >

Stratum 1 = {NONFIN}

> >

Stratum 2 = {WSP}

> >

Stratum 3 = {FT-TYPE$_{IAMB}$}

The above stratified hierarchy reads as the initial stratum (and all the constraints housed in it) dominates stratum 1 and stratum 2 and 3 by transitivity.

It is noteworthy that the interaction of WSP and NONFIN in stress assignment in English verbs was found not to incur any difficulties for most of the participants. This state of affairs is explained by the fact that the constraints in question are similarly ranked in the learners' L1. Consider tableau (17).

(17) The interaction of WSP and NONFIN in English verbs: (e.g., commence)

/kə mens /	FT-TYPE$_{TROC}$	WSP	NON-FIN	ALIGNH-R	FTBIN-μ	PARSE-σ	FT-TYPE$_{IAMB}$
a. * μ (μμ) ☞ kəmens			*			*	*

b. * (μ μ)μ kəmeˈns		*!		*		*	*
c. * (μ μμ) kəmeˈns		*!	*		*		*
d. * (μ μ) kəmeˈns		*!	*				*
e. * (μ μ) kəmeˈns	*!		*				

Similar to MA, in English verbs, WSP outranks NONFIN. Therefore, as was predicted by CDA, learners did not need to go through this stage of demoting WSP below NONFIN to reach the optimal form. Had they demoted WSP below NONFIN, they would have optimized the wrong output.

The domination relation in (16) is still not the final hierarchy. The data available to learners falsify the ranking in (16). Learners come to realize that further demotion is in order to improve the existing domination hierarchy. Another determining constraint to stress placement is ALIGNHD-R which is in conflict with WSP. Consider tableau (18), which captures the conflict between these two constraints in the stress pattern of learners' L1.

(18) The interaction of ALIGNHD-R and WSP in learners' L1: 'SanDaLa' (sandal)

/SanDaLa/	ALIGNHD-R	WSP
a. ˈSan.Da.La	**!	
☞ b. San.ˈDa.La		*

Candidate (a) is ruled out due to stress location on the absolute left edge of the word, therefore, incurring a fatal violation of ALIGNHD-R. Candidate (b), on the other hand, is the most harmonic as it satisfies the higher ranked constraint.

When learning English, Moroccan learners hypothesized that ALIGNHD-R >> WSP. Tableau (19) illustrates learners' transfer of the L1 constraint ranking into the English stress pattern.

(19) IL: a transferred constraint hierarchy from MA

/serɪməni/	FT-TYPE$_{TROC}$	ALIGNHD-R	WSP
a. (ˈser.ɪ)mə.ni		**!	
💣 b. (ser.ɪ)(ˈmə.ni)			*
c. ser(ɪ.ˈmə)ni	*!	*	*
d. ser(ˈɪ.mə)ni		*!	*

The transferred ranking favors the suboptimal candidate (b) (that is ruled out by the English hierarchy), for it best satisfies the higher ranked constraint. Candidates (a), (c), and (d) lose the competition due to their violation of ALIGNHD-R, candidate (c) also violates the high ranked constraint FT-TYPE$_{TROC}$. The consequence of the L1 transferred hierarchy is the optimization of the wrong system in the learners' IL.

English data contain evidence as to disconfirm the ranking of ALIGNHD-R>>WSP that Moroccan learners have already acquired as part of their L1 grammar. The next stage, as learners are exposed to data, brings evidence for the demotion of ALIGNHD-R into a lower position. This demotion is illustrated below:

(20) The demotion of ALIGNHD-R below WSP

/serɪməni/	FT-TYPE$_{TROC}$	ALIGNHD-R	WSP
a. (ˈser.ɪ)mə.ni		**!	
b. (ser.ɪ)(ˈmə.ni)			*
c. ser(ɪ.ˈmə)ni	*!	*	*
d. ser(ˈɪ.mə)ni		*!	*

Tableau (20) above illustrates the process of the demotion of ALIGNHD-R because the newly accessed evidence showed that this constraint is dominated by WSP. The result of learners' demotion is represented in tableau (21):

(21) Optimization of stress assignment in the English system

/serɪməni/	FT-TYPE$_{TROC}$	WSP	ALIGNHD-R
☞ a. (ˈser.ɪ)mə.ni			**
b. (ser.ɪ)(ˈmə.ni)		*!	
c. ser(ɪ.ˈmə)ni	*!	*	*
d. ser(ˈɪ.mə)ni		*!	*

Tableau (21) demonstrates the convergence from learners' IL into the English stress pattern ranking employing CDA. The result of this demotion is a hierarchy identical to the English hierarchy in that it secures that a heavy syllable receives stress regardless of the position of the syllable. In the word *ceremony*, for instance, stress is attracted to the heavy syllable, although stress is placed on the absolute left edge of the word. The opposite holds true in learners' L1 (cf. the example in tableau (18)).

In tableau (21), candidate (a) is the optimal output thanks to its satisfaction with the high ranked constraints. Candidates (b) and (d) are ruled out for they fatally violate WSP by placing stress on a light syllable. Candidate (c) loses the competition due to its violation of the highest ranked constraint. By demoting ALIGNHD-R, learners correctly optimize the actual output in English. (22) captures another stage in the learning process of English stress that is characterized by demoting ALIGNHD-R to a lower stratum.

(22)

Initial Stratum = {ALIGNHD-R, Ft-BIN, PARSE-σ, Ft-TYPE$_{TROC}$}
>>
Stratum 1 = {NONFIN}
>>
Stratum 2 = {WSP}
>>
Stratum 3 = {ALIGNHD-R}
>>
Stratum 4 = {FT-TYPE$_{IAMB}$}

This stratified hierarchy indicates the optimized ranking in tableau (21), wherein WSP dominates ALIGNHD-R.

Another relevant constraint to our analysis of stress learnability is Ft-BIN which is in conflict with WSP. Consider the account of stress location in the word *agenda* below:

(23)

Ft-BIN (FOOT-BINARITY): Feet are binary at some level of analysis (μ, σ).

(24)

/ədʒendə/	WSP	Ft-BIN
☞ a. ə(ˈdʒen)də		*
b. (ˈə.dʒen)də	*!	

Candidate (a) is the optimal output as it satisfies WSP even though the foot is not binary at the level of syllabic analysis. Candidate (b), on the other hand, is ruled out because stress does not fall on the heavy syllable, although it satisfies Ft-BIN.

As was predicted by CDA, Moroccan learners of English do not encounter difficulties relative to the interaction of WSP and Ft-BIN. This state of affairs recourses to positive evidence, which is a result of a similar ranking, as promised by CDA. Positive evidence lies in the winning candidate that learners optimize, which shows that the established hierarchy is correct, as in tableau (24).

Notice that learners, at this stage, could not generate a candidate as (gəˈrɑːʒ). We believe that at this stage of acquisition, learners have already established a ranking where FT-TYPE$_{IAMB}$ is not attested in English. Hence, such candidates are excluded due to the fatal violation of FT-TYPE$_{TROC}$.

Overall, Ft-BIN did not cause any difficulty for learners as it similarly interacts with WSP in MA; hence, they optimize a structure in conformity with TL grammar. Learners needed to house it (Ft-BIN) in a stratum below. (22) is reproduced in (25) below to secure the ranking WSP>> Ft-BIN:

(25)

Initial Stratum = {PARSE-σ, Ft-TYPE$_{TROC}$}
>>
Stratum 1 = {NONFIN}
>>
Stratum 2 = {WSP}
>>
Stratum 3 = {ALIGNHD-R, Ft-BIN}
>>
Stratum 4 = {FT-TYPE$_{IAMB}$}

This stratified hierarchy reads as while Ft-BIN is unranked relative to ALIGNHD-R, they are both dominated by WSP and all above strata (1 and initial). They, on the other hand, dominate stratum 4.

Ft-BIN is also in conflict with PARSE-σ, which bans unfooted syllables. In English grammar, it is well established that Ft-BIN dominates PARSE-σ. Consider tableau (27), which illustrates the interaction of these two constraints along with other decisive constraints in stress account.

(26)

PARSE-σ: Syllables are parsed by feet.

(27) The interaction of Ft-BIN and PARSE-σ

/əmerɪkə/	FT-TYPE$_{TROC}$	NONFIN	WSP	ALIGNHD-R	Ft-BIN	PARSE-σ
a. ə.(ˈmer)ɪ.kə					*!	***
b. (ˈə.mer)ɪ.kə			*!			**
c. (ə.mer)(ˈɪ.kə)		*!	*			
d. (əˈmer)(ɪ)kə	*!		*		*	*
☞ e. ə(ˈmer.ɪ)kə						**

This tableau indicates the ranking that Ft-BIN dominates PARSE-σ; hence, *A(meri)ca* (candidate e) is more harmonic than its competitors. As principled in CDA, this hierarchy does not cause difficulties for Moroccan learners as it is equally ranked in their L1 grammar. This is another example of positive evidence. At this stage, all learners were required to do was to place PARSE-σ in a stratum below Ft-BIN. This ranking is illustrated in the following stratified hierarchy.

(28)

Initial Stratum = {Ft-TYPE$_{TROC}$}
>>
Stratum 1 = {NONFIN}
>>
Stratum 2 = {WSP}
>>
Stratum 3 = {ALIGNHD-R, Ft-BIN}
>>
Stratum 4 = {PARSE-σ}
>>
Stratum 5 = {FT-TYPE$_{IAMB}$}

The stratified hierarchy represents the stages of the learning process that learners went through to reach the optimized stress pattern. In the absence of further negative evidence, Moroccan learners adopt the hierarchy in (28), for it optimizes solely the correct output in the target language.

6. Conclusion and Implications

The aim of this research paper has been to offer an OT analysis of English word-stress learnability. Adopting the framework of the Constraint Demotion Algorithm (Tesar & Smolensky, 2000/2006) to account for this process, this study has attempted to enquire about the effect of L1 ranking on stress acquisition and to test if OT can predict the stages of the learning process. It decomposes word-stress learnability problems and shows how learners, by means of CDA, can deduce the constraint ranking particular to a target language. Given the structural descriptions of negative evidence (data), demoting constraints allows efficient convergence to correct grammar.

We conclude that most errors are traceable to the unconformity between the constraint hierarchy of English and MA. One can also conclude that learners' L1 constraint ranking affects their acquisition of English word-stress. Leaners' IL is a fluctuation between the hierarchy of their mother tongue and the target language. However, as language develops and with sufficient adequate exposure to the input, Moroccan learners optimize the hierarchy of the target language and succeed in avoiding fossilization in this area.

Given its deeper linguistic explanation, OT can successfully predict learning stages using CDA (Tesar & Smolensky, 2000). It is established that CDA is relevant to language learnability. First, CDA is an algorithm that was straightforwardly adopted to account for L2 acquisition problems. Second, the algorithm has succeeded in predicting the stages in the L2 acquisition process. As predicted by CDA, in every phase, a constraint is demoted to a lower stratum, and a new hierarchy is established and housed in a particular stratum (the absence of lower stratum results in creating a new one). When more constraints are demoted, a number of strata are created to house the established hierarchy. Each stratum (a hierarchy) represents a stage in the language learning process, as shown in the stratified hierarchy in (28), wherein each stratum implies a learning stage.

Educators and syllabus designers can have deep insights into Moroccan EFL learners' pronunciation errors in producing English stress and predict these errors in various phonological distributions. Therefore, the learners' persistent stress errors can be targeted and called attention to by syllabus designers and language teachers. When the errors and their sources are identified, educators can easily and effectively assign remedial work. The OT analysis has succeeded in predicting the stages in the L2 acquisition process. When the developmental stages are defined, syllabus designers can present pronunciation aspects in gradual, developmental, and systematic organisations. Thus, the learning stages defined in this study by means of CDA can be considered when teaching stress. As for the teaching approach of word-stress, there are tangible arguments in favour of the inductive approach (rule-discovery) over the deductive approach (learners being given a rule: rule-driven). Although there are benefits to both approaches, a number of researchers and practitioners have recommended implicit teaching. For instance, Krashen (1982; 1985) and Krashen and Terrel (1983) recommended that teachers provide comprehensible input instead of presenting an item (say word-stress pattern in this case) explicitly. Nevertheless, while we believe that deductive and inductive teaching should not look at as competing approaches but rather as two approaches that complete each other, the adoption of each depends on a number of factors (e.g., the nature of the target item, learners' age, and the preferences of the teacher and learners). By way of illustration, inductive teaching of English

stress patterns is often seen as advantageous in high school classrooms. Conversely, university learners (adults) favour deductive teaching because they like to analyze grammar patterns.

We also recommend the application of computer-assisted pronunciation training (CAPT) to visually and instrumentally teach pronunciation. A CAPT program that was proposed as a pedagogical tool to effectively teach word-stress is Praat (open-source acoustic analysis software) in Smirkou's study. In his experimental study, Smirkou (2022) has attempted to assess the effectiveness of Praat incorporation in teaching word-stress. The result obtained from the Independent Samples t-test shows that Sig. (2-tailed) score was 0.004, smaller than the significance value of 0.05. Thus, the use of Praat has a positive effect on EFL learners' pronunciation. By opening up analysis of the visual medium and visual measurement of acoustic properties, Moroccan learners succeeded in improving word-stress pronunciation. Praat also helps learners self-identify their pronunciation problems, self-correct them by comparing their speech with that of native speakers, and self-pace their learning.

The present paper has attempted to contribute to L2 phonology in the Moroccan context, an area of research which is scarce. Using CDA, it has studied the role of crosslinguistic influence on the acquisition of L2 phonology, particularly in the acquisition of English word-stress among Moroccan learners. The overall findings of the present study can be captured as follows:

- Learners' prior (L1) ranking (ALIGNHD-R >> WSP >>NONFIN >> Ft-TYPE$_{IAMB}$>>Ft-BIN >> PARSE-σ >> Ft-TYPE$_{TROC}$) influences their learnability of English stress.
- Moroccan learners misplace stress in English words due to the initial state of their native grammar.
- The relevance of the Constraint Demotion Algorithm to L2 acquisition is evident. Each demotion captures a hierarchy, and each hierarchy represents a stage in the learning process.
- As predicted by CDA, the interaction of WSP and Ft-BIN and that of Ft-BIN and PARSE-σ do not cause any difficulty for learners as they are similarly ranked in their L1. Learners also do not encounter difficulty in stress location in verbs (WSP and NONFIN similarly interact in their L1).
- Making use of CDA, learners can optimize the hierarchy of the target language (stress pattern), as represented in (28).

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