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ON TASHLHIT ROOT STRUCTURE AND ITS IMPLICATIONS FOR THE ORGANIZATION OF THE LEXICON

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By

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DEDICATION

To the memory of grandpa, the dearest person who unfortunately can't be here today to see that his wishes have finally come true.

To mommy, who has helped me become the person I am today.

To granny, who has always been there for me.

To Mouad, who has always been understanding and supportive.

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ABSTRACT

ON TASHLHIT ROOT STRUCTURE AND ITS IMPLICATIONS FOR THE ORGANIZATION OF THE LEXICON

By

Fatima EL HAMDI

The role of morphological theories in understanding how the lexicon is organized has been the topic of research of a number of studies. This topic brings two contrasting views to the fore. Some researchers claim that the lexicon consists of independent polymorphemic words with no need of a decomposition theory. This approach has been advocated in Amazigh and other Semitic languages like Hebrew and Arabic, pointing to the fact that the morphology of the language is better explained using a word-based approach. Arguments have been presented from Hebrew verb morphology (Bat-El, 1994; Aronoff, 1994; Ussishkin, 1999) and from Arabic verbal and nominal morphology (Hammond, 1988; McCarthy and Prince, 1990; Guerssel and Lowenstamm, 1996; Benmamoun, 2003).

Contrastively, others argue that polymorphemic words are decomposed into morphemes among which we cite the base form or the root (Cantineau, 1950; McCarthy, 1981; Galand, 1984; Chaker, 1990; Tobin, 1990; among others). Evidence for the root-based theory has been provided from language games (Arabic: McCarthy, 1981; Tashlhit: Lahrouchi, 2004, 2018a), metathesis (Prunet, Béland and Idrissi, 2000), and from behavioral studies (Deutsch, Frost and Forster 1997, 1998, 2000; Boudelaa and Marslen-Wilson, 2001, 2004a-b, 2005; Ussishkin and Twist, 2009; Ussishkin, Dawson, Wedel and Schluter, 2015). According to this view, the root is accessed very quickly in studies of language processing.

In the present work, we contributed to the debate on the two views on morphological theory and discussed the theoretical implications for the organization of the lexicon. We tried to investigate the notion of roots in Amazigh, more particularly in Tashlhit and we attempted to answer two main research questions. First, is the root a morphological unit in the Tashlhit lexicon? Second, is the root exclusively consonantal in Tashlhit? With this end in view, we investigated the lexical properties of root structure in Tashlhit by distinguishing between two types of roots, the vocalic and the consonantal. We provided arguments supporting the claim that in addition to consonantal roots, the Tashlhit lexicon consists of roots that have vowels and consonants alike.

The novelty of this dissertation is that it discusses the significance of the root from a perspective that is not only purely morphological but also psycholinguistic. We presented further arguments for the presence of vowels in Tashlhit roots and also conducted, for the first time in Amazigh studies, priming experiments to examine language processing. The data analyzed comes essentially from the variety spoken in Ighrem N'Ougdal area and its surroundings, a place which is largely representative of the Tashlhit language.

At the theoretical level, we carried out our analysis under the premises of Optimality Theory (Prince and Smolensky, 1993/2004; McCarthy and Prince, 1993, 1995). We presented facts from the verbal and nominal morphology of the language, and we tried to account for the linguistic irregularities through constraint ranking. We resorted to Correspondence Theory (McCarthy and Prince, 1995) and to Positional Faithfulness theory (Beckman, 1998) with main reference to the root morpheme to account for some aspects of the morphological system of the language. Using the interaction between faithfulness and markedness constraints and root faithfulness constraints, we also argued for the presence of vowels in the root structure of Tashlhit assuming that input root elements, be they vocalic or consonantal, are preserved in the output.

At the psycholinguistic level, we followed the assumption that linguistic phenomena are not exempt from extralinguistic factors (Berent & Shimron, 1997, 2003; Frish & Zawaydeh, 2001; Prunet, Béland & Idrissi, 2000). More specifically, we discussed data from priming experiments, based on measuring the reaction times of the participants. This type of experiment generally exposes participants to a stimulus (prime), which influences their response to a subsequent stimulus (target).

This dissertation is organized into five chapters. Chapter I sketches the characteristics of the Tashlhit phonological and morphological system, on the one hand, and the root structure in Hamitic-Semitic languages, on the other. Chapter II presents the premises on which our analyses are based. As a reminder, our work is organized in a twofold fashion: one part provides the theoretical analysis and the argumentation for the root structure and the second part adduces external evidence for the significance of the root. In this chapter, we, first, present an overview of the Optimality Theoretic framework, Correspondence Theory and Positional Faithfulness. Second, we introduce the priming tests we used in conducting our experiments. In chapter III, we provide further arguments in favor of the root-based approach. We discuss in further detail the relevance of the root in understanding the verbal and nominal morphology of Tashlhit, and we also distinguish between vocalic and consonantal roots in the Tashlhit lexicon. Ample evidence is presented in support of the bipartite system of Tashlhit roots. In chapter IV, we test the semantic priming effect in the language as we have more regular overlappings of semantics and morphology in the language. We present the details of the methodology adopted in all the priming experiments we use in this study. We also introduce the pretests we use to select our experimental stimuli, namely the frequency and the semantic pretests. Last but not least, chapter V examines the morphological priming effect as external evidence for the role of morphology in the language and test the other linguistic factors (semantics and phonology) that may interfere with the root.

The results of our theoretical and empirical analyses show that the root is an essential morphemic unit that plays an important role in the understanding of language processing. We prove that roots in Tashlhit have some psycholinguistic reality and, hence, they have significant implications for the organization of the Tashlhit lexicon. We obtain the same result with semantic features that show a significant priming effect, suggesting the lexicality of semantic features in the Tashlhit lexicon. Only phonological properties do not facilitate lexical access, leading to the conclusion that phonology has no role in word recognition processes. We also argue for the coexistence of both consonantal and vocalic roots in the Tashlhit lexicon.

RESUMÉ

LA STRUCTURE DE LA RACINE EN TACHELHIT ET SES IMPLICATIONS POUR L'ORGANISATION DU LEXIQUE

Par
Fatima EL HAMDI

Le rôle des théories morphologiques dans la compréhension de l'organisation et de la structuration du lexique a été le sujet d'un certain nombre de travaux de recherche. Le travail présenté ici constitue une contribution à ce domaine de recherche. La réflexion initiale s'appuie sur un débat ancien interrogeant la structure et l'organisation du lexique en berbère. Certains chercheurs affirment que le lexique se compose de mots polymorphémiques indépendants stockés tels quels. Cette approche a été préconisée d'abord pour rendre compte de langues sémitiques comme l'hébreu et de l'arabe puis étendue à l'amazighe. Des arguments ont été présentés à partir de la morphologie du verbe hébraïque (Bat-El, 1994; Aronoff, 1994; Ussishkin, 1999) et de la morphologie du verbe et du nom de l'arabe (Hammond, 1988; McCarthy and Prince, 1990; Guerssel et Lowenstamm, 1996; Benmamoun, 2003). A l'inverse, d'autres chercheurs soutiennent l'idée que pour ces langues, les mots complexes sont stockés sous la forme d'une racine consonantique. Des arguments en faveur de ce morphème ont été fournis par des jeux de langue (Cantineau, 1950; McCarthy, 1981; Galand, 1984; Chaker, 1990; Tobin, 1990), la métathèse (Prunet, Béland et Idrissi, 2000) et des études perceptives (Frost, Forster et Deutsch, 1997, 1998, 2000; Boudelaa et Marslen-Wilson, 2001, 2004a-b, 2005; Ussishkin et Twist, 2009; Ussishkin, Dawson, Wedel et Schluter, 2015). De ce point de vue, la racine est considérée comme une unité de morphologie disponible pour le locuteur-auditeur lors des tâches de traitement de la parole comme l'ont montré les travaux en psycholinguistique.

Dans le présent travail, nous avons pour objectif de contribuer à ce débat par des analyses morphologiques et psycholinguistiques et d'en discuter les implications sur la compréhension de l'organisation du lexique en amazighe. Nous avons étudié la notion de racine en amazighe, plus particulièrement en tachelhit et nous avons tenté de répondre à deux principales questions de recherche. Nous nous sommes d'une part demandé si la racine était une unité morphologique représentée dans le lexique du tachelhit ; ensuite si cette racine était exclusivement consonantique. A cette fin, nous avons étudié la structure de la racine et ses propriétés lexicales en tachelhit et mis en évidence la possibilité de l'existence de deux types de racine : d'une part la racine consonantique, qui ne contient que des consonnes, telle qu'elle est envisagée classiquement en berbère ; mais également une racine vocalique qui contiendrait voyelles et consonnes. Nos travaux valident cette hypothèse selon laquelle, en plus des racines consonantiques, le lexique de tachelhit se compose aussi de racines vocaliques.

L'originalité de nos travaux repose sur une double validation de cette hypothèse. En effet, à côté des arguments morphologiques en faveur de l'existence des racines vocaliques en tachelhit, nous avons mené, de manière inédite en amazighe, une étude psycholinguistique montrant qu'elles étaient effectivement disponibles en perception et traitées par des locuteurs natifs du tachelhit. Les données analysées s'appuient sur l'étude de la variété d'amazighe parlée

dans la zone d'*Ighrem N'Ougdal* et de ses environs. Ces endroits où nous avons recueilli les données sont largement représentatifs du tachelhit.

Sur le plan théorique, nous avons fondé notre travail sur les principes de la théorie de l'Optimalité. Nous avons présenté les faits de morphologie verbale et nominale observables dans cette langue, que nous avons analysés à la lumière de la théorie de la correspondance et de la théorie de la fidélité positionnelle. Sur la base de l'étude de l'interaction entre les contraintes de fidélité, celles de marque et celles de fidélité à la racine, nous avons démontré la présence de voyelles dans la racine de tachelhit, en supposant que les éléments radicaux, que ce soient vocaliques ou consonantiques, sont préservés de l'input à l'output.

Du point de vue psycholinguistique, nous avons produit et analysé des données à partir d'expériences de priming basées sur la mesure du temps de réaction des participants et visant à vérifier si des racines morphologiques de ce type étaient disponibles en perception pour des locuteurs du tachelhit. Ces expériences avaient pour objectif de fournir des arguments empiriques en faveur de la racine en tachelhit.

Cette thèse est organisée en cinq chapitres. Le premier chapitre présente les caractéristiques principales du système phonologique et morphologique en tachelhit ainsi que la structure de la racine dans les langues chamito-sémitiques. Le deuxième chapitre expose les prémices sur lesquelles repose notre double analyse morphologique et psycholinguistique de ces faits. Nous avons donc présenté d'abord, la théorie de l'Optimalité, et plus précisément les bases de la théorie de la correspondance et de la théorie de fidélité positionnelle. Ensuite, nous avons présenté les tests de priming que nous avons utilisés dans nos expériences. Au chapitre III, nous avons discuté plus en détail l'hypothèse de l'existence de la racine dans la compréhension de la morphologie verbale et nominale du tachelhit et nous avons également introduit la distinction nécessaire selon nous entre les racines vocalique et consonantique dans le lexique du tachelhit. Le quatrième chapitre présente les expériences rendant compte de l'effet de la sémantique dans le traitement de la racine en tachelhit qui nous ont amené à considérer qu'il existait des interactions entre la sémantique et la morphologie lors du traitement de ces objets. Nous détaillons notre méthodologie et présentons les tests préliminaires, à savoir le test de fréquence et celui de relation sémantique, que nous avons utilisés pour sélectionner nos stimuli expérimentaux. Enfin, dans le cinquième chapitre nous examinons le rôle de la morphologie dans la langue ainsi que celui d'autres facteurs linguistiques (sémantiques et phonologiques) qui auraient pu interférer avec la racine dans le processus d'accès lexical.

Nous montrons que les racines ont une réalité psycholinguistique et, que par conséquent, elles ont des implications importantes dans l'organisation du lexique de tachelhit. Nous montrons également l'interaction entre les informations morphologiques et sémantiques qu'utilisent les locuteurs puisque la sémantique semble avoir un effet facilitateur dans l'accès lexical. A l'inverse, les traits phonologiques ne semblent pas être utilisés lors de la reconnaissance des mots, ce qui impliquerait qu'ils n'ont pas de statut lexical en tachelhit.

Pour conclure, ce travail contribue à enrichir un débat ancien en morpho-phonologie du berbère. En effet les résultats de nos analyses théoriques et empiriques apportent des arguments importants en faveur de l'existence d'une racine morphologique lexicalement disponible pour les locuteurs et qui joue un rôle très important dans le traitement du tachelhit. Ils plaident également en faveur de la coexistence de deux types de racines : consonantique et vocalique dans le lexique de tachelhit.

ملخص

بنية الجذر في لهجة تشلحيت وآثارها على تنظيم المعجم

من إعداد
فاطمة الحمدي

يساهم العمل الذي نقدمه في إغناء الابحاث التي تتطرق للدور الذي تلعبه نظريات التغيرات الشكلية في فهم بنية المعجم وآليات تنظيمه. ويرى بعض الباحثين أن المعجم يتكون من كلمات متعددة المور فيمات مستقلة وتخزن كما هي. استعمل أولا في شرح عدد من اللغات السامية مثل العبرية والعربية ثم امتد إلى الأمازيغية بناء على الحجج من مورفولوجيا الفعل في العبرية، ومورفولوجيا الفعل والاسم في العربية. على عكس ذلك، دعم غيرهم من الباحثين فكرة أن الكلمات في هذه الالعاب اللغوية، القلب مبنية على اللغات المعقدة، مخزنة في شكل جذور ساكنة. الحجج التي قدمت لصالح هذا المورفيم المكاني أو الإبدال، ودراسات في التصور. ويعتبر الجذر من وجهة النظر هذه، يعتبر وحدة التشكل المتاحة للمتكلم أو المستمع في مهام معالجة الكلام، كما هو مبين من خلال العمل في علم اللغة النفسي.

من خلال هذا العمل، نهدف إلى المساهمة في هذا النقاش من خلال التحليلات الصرفية واللغوية النفسية ومناقشة الآثار المترتبة على تنظيم المعجم في الأمازيغية. درسنا مفهوم الجذر في الأمازيغية، وخاصة في تشلحيت وحاولنا الإجابة على سؤالين بحثيين هامين. نبحث أولا عما إذا كان الجذر وحدة التشكل الممثلة في معجم اللغة تشلحيت، ثم إذا كان هذا الجذر ساكنا فقط. لهاته الغاية، قمنا بدراسة بنية الجذر وخصائصه المعجمية في اللغة تشلحيت، وسلطنا الضوء على إمكانية وجود نوعين من الجذر: الجذر الساكن الذي يحتوي فقط على الحروف الساكنة، مثل الذي يعتبر كلاسيكيا في الأمازيغية، وأيضا جذر العلة الذي من شأنه أن يحتوي على حروف العلة والحروف الساكنة. عملنا بالتحقق من صحة الفرضية التي مفادها أنه بالإضافة إلى الجذر الساكن، معجم اللغة تشلحيت يتكون أيضا من جذر العلة.

يعتبر عملنا أصيلا إذ أنه يقوم بمضاعفة التحقق من صحة هذه الفرضية. والواقع أنه إلى جانب الحجج المورفولوجية التي قدمناها لصالح وجود جذور العلة في تشلحيت، أجرينا بطريقة لم يسبق لها مثيل في الأمازيغية، دراسة علم اللغة النفسي حيث تبين أن جذور العلة كانت متاحة بالفعل في التصور و تمت معالجتها من قبل الناطقين. وقد قمنا بتحليل البيانات التي حصلنا عليها بناء على دراسة مجموعة متنوعة من المعطيات الأمازيغية في منطقة عمالة إغرم نوكدال والمناطق المحيطة بها، مراعين في ذلك تمثيلية هذه البيانات لتشلحيت.

على المستوى النظري، اعتمد عملنا على مبادئ النظرية المفاضلة (La théorie de l'Optimalité).عرضنا الوقائع المورفولوجية الاسمية والفعلية التي يمكن ملاحظتها في هذه اللغة والتي تم تحليلها في ضوء نظرية التناظر العينية (la théorie de la correspondance) ونظرية الموضعية (la théorie de la fidélité positionnelle) . على أساس دراسة التفاعل بين قيود هاته النظرية، قد برهنا على وجود جذر العلة في تشلحيت، على افتراض أن العناصر الجذرية، سواء كانت حروف العلة أو الحروف الساكنة، يتم الاحتفاظ بها من المدخلات إلى المخرجات.

من وجهة نظر علم اللغة النفسي، فتحليل البيانات من التجارب التي قمنا بها تقوم على قياس رد الفعل من المشاركين للتحقق مما إذا كان الجذر الصرفي متوفرا في تصور الناطقين باللغة تشلحيت. و بالتالي، فذلك يهدف الى تقديم الحجج والأدلة التجريبية لصالح الجذر في تشلحيت.

تنقسم هذه الأطروحة إلى خمسة فصول. الفصل الأول يعرض أهم خصائص النظام الصوتي والصرفي في تشلحيت، وكذلك بنية الجذر في اللغات الحامية -السامية. الفصل الثاني يعرض المبادئ التي نستند عليها في التحليل الصرفي وفي علم اللغة

النفسي لهاته الحقائق. ولذلك قدمنا أولا النظرية المفاضلة، وعلى نحو أدق أسس نظرية التناظر العينية ونظرية الموضعية. ثم قدمنا التقنيات المستخدمة في التجارب. في الفصل الثالث ناقشنا المزيد من التفاصيل حول فرضية وجود الجذر في فهم مورفولوجيا الفعل والاسم في تشلحيت كما أوضحنا أيضا أنه من الضروري التمييز بين الجذر الساكن وجذر العلة في قاموس تشلحيت. الفصل الرابع يعرض التجارب التي أخذناها بعين الاعتبار في التأثير الدلالي في علاج الجذور في تشلحيت التي أدت بنا إلى النظر في أن هناك تفاعلات بين الدلالات أو المعنى والمورفولوجيا أثناء معالجة اللغة. قمنا أيضا بتقديم تفاصيل منهجية الاختبارات الأولية، وهي اختبار التردد والعلاقة الدلالية والتي اعتمدنا عليها في اختيار المحفزات التجريبية. وأخيرا في الفصل الخامس درسنا دور المورفولوجيا في اللغة، فضلا عن عوامل لغوية أخرى (الصوتية والدلالات) التي يمكن أن تتداخل مع الجذر في عملية الوصول المعجمية.

وتبين لنا أن الجذورلها واقع لغوي نفسي، وبالتالي، فإن لها دور هام في تنظيم معجم تشلحيت. كما اتضح لنا أن هناك تفاعل بين المعلومات الصرفية والدلالية المستخدمة من قبل المتحدثين. ومن ذلك نستخلص أن للدلالات دور مهم في تسهيل عملية الوصول المعجمية. على عكس ذلك، فلا يبدو أنه يتم استخدام الصفات الصوتية خلال التعرف على الكلمات، مما يعني أنه ليس لديها أي دور في وضع معجم تشلحيت.

نستنتج إذن أن هذا العمل يساهم في إثراء نقاش قديم في مورفولوجيا وعلم الأصوات في الأمازيغية. في الواقع، فإن النتائج النظرية والتجريبية تقدم حججا هامة لوجود الجذر الصرفي في المعجم والذي يلعب دورا هاما جدا في علاج لغة تشلحيت. هاته الحجج تبرهن أيضا على وجود نوعين من الجذور: الساكنة وجذور العلة في قاموس تشلحيت.

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LIST OF ABBREVIATIONS

Act. N.	Action Noun
Adj.	Adjective
Aff	Affix
Ag. N.	Agentive Noun
Aor.	Aorist
Cond	Condition
Croot	Consonantal root
CS	Construct State
Fem.	Feminine
FS	Free State
Imperf.	Imperfective
Instr. N	Instrument Noun
L	Left
LDT	Lexical Decision Task
LRT	Likelihood ratio test
Lmer	Linear mixed effect regression
Masc.	masculine
ms	millisecond
m1	model 1
Neg.	negative
NN	Nonwords primed with nonwords
N.	Noun
OCP	Obligatory Contour Principle
OT	Optimality Theory
p.	person
Perf.	Perfective
Phon	Phonology
Pl. N	Place Noun
RT	Reaction Time
RT offset	Reaction time measured from target offset
RT onset	Reaction time measured from target onset
RR	Real words primed with read words
RM	Realize Morpheme
R	Right
Rt	Root
sem	semantics
sg.	Singular
SOA	Stimulus Onset Asynchrony
V.	Verb
Vroot	Vocalic root

GENERAL INTRODUCTION

The role of morphological theories in understanding how the lexicon is organized has been the topic of research of a number of studies. This topic brings two contrasting views to the fore.

Some researchers claim that the lexicon consists of independent polymorphemic words with no need of a decomposition theory. This approach has been advocated in Amazigh and other Semitic languages like Hebrew and Arabic, pointing to the fact that the morphology of the language is better explained using a word-based approach. Arguments have been presented from Hebrew verb morphology (Bat-El, 1994; Aronoff, 1994; Ussishkin, 1999) and from Arabic verbal and nominal morphology (Hammond, 1988; McCarthy and Prince, 1990; Guerssel and Lowenstamm, 1996; Benmamoun, 2003).

Contrastively, others argue that polymorphemic words are decomposed into morphemes among which we cite the base form or the root (Cantineau, 1950; McCarthy, 1981; Galand, 1984; Chaker, 1990; Tobin, 1990; among others). Evidence for the root-based theory has been provided from language games (Arabic: McCarthy, 1981; Tashlhit: Lahrouchi, 2004, 2018a), metathesis (Prunet, Béland and Idrissi, 2000) and from behavioral studies (Deutsch, Frost and Forster, 1997, 1998, 2000; Boudelaa and Marslen-Wilson, 2001, 2004a-b, 2005; Ussishkin and Twist, 2009; Ussishkin, Dawson, Wedel and Schluter, 2015). According to this view, the root is accessed very quickly in studies of language processing.

In Amazigh[1], the debate on the root structure is not just about the role played by the root morpheme but also about the root structure itself. First, under the structuralist view, the root is a unit consisting of consonants only; the vowels are part of the template (Galand, 1988; Chaker, 1990; Taïfi, 1991; Lahrouchi and Ségéral, 2009; Lahrouchi, 2018a). Based on this view, consonantality is the main characteristic of Amazigh roots and that consonantal roots are the lexically represented morphemes, whereas vowels carry grammatical information. This implies that the exctraction of roots involves the extraction of radical consonants only. No vowel is considered radical or lexical in this approach. Furthermore, the assumption that lexical roots are exclusively consonantal has strong implication in the studies of lexicography. Several dictionaries have considered the consonantal root as their main entry to which other derivations are linked (Foucauld, 1951; Dallet, 1982; Taïfi, 1991).

An alternative approach challenges the consonantal root and suggests that the way the lexicon is organized into consosnantal morphemes should be reconsidered. For the sake of illustration, a remarkable repercussion of the consonantal root hypothesis on the way dictionaries are generated is that it results into the prevalence of homophones in the same dictionary. For example, Taine-Cheikh (2006) claims that 12 roots (√*GL*) are cited in Dallet (1982) (*Dictionnaire kabyle-français*).[2] Another issue that cannot be accounted for, using the consonantal root is of concern to the initial vowel in the construct state of Amazigh nouns (Applegate, 1958; Abdel-Massih, 1971; Saib, 1982; Guerssel, 1983; Brugnatelli, 1987, 1997; Chaker, 1988; Vycichl, 1989; Dell and Jebbour, 1991; Jebbour, 1991; Elmedlaoui, 1992;

[1] Amazigh is also referred to as Berber in the literature. From a sociolinguistic point of view and in the Moroccan context, the term 'Berber' might be interpreted as having negative connotations for its Ancient Greek origin (Errihani, 2007). Yet, because the terms *Amazigh, Tamazight, Imazighen* may be confusing for the Western audience, Berber is widely used in the literature with no negative interpretations about the language, at least among scholars (Ennaji, 2005). To avoid any sociolinguistic misinterpretation, we will use the term 'Amazigh' throughout this dissertation as it has been the official name of the language in Morocco since 2011.

[2] Taine-Cheikh (2009) also cited the issue of the representation of the vowel length in the dictionary (eg. The author questions whether the verb *yäyiyä* 'born' would be stated in the dictionary as a derivation of *YY?* or *Y?*).

Bensoukas, 2001, 2010; Lahrouchi, 2013; El Hankari, 2014; Ben Si Said, 2014; El Hamdi, 2018). A reconsideration of certain vowels as radical rather than morphological or templatic is appealed to for a better explanation of the linguistic irregularities (Iazzi, 1991, 1995; Dell and Elmedlaoui, 1992, 2003; Kossmann, 1997; Bensoukas, 2001, 2018; Boumalk, 2018, El Hamdi, 2018).

In the present work, we aim to contribute to the debate on the two views on morphological theory and discuss the theoretical implications for the organization of the lexicon. We will try to investigate the notion of roots in Amazigh, more particularly in Tashlhit and we will attempt to answer two main research questions. First, is the root a morphological unit in the Tashlhit lexicon? Second, is the root exclusively consonantal in Tashlhit? With this end in view, we will investigate the lexical properties of root structure in Tashlhit by distinguishing between two types of roots: the vocalic and the consonantal. We will try to provide arguments supporting the claim that in addition to consonantal roots, the Tashlhit lexicon consists of roots that have vowels and consonants alike.

This research discusses the significance of the root from a perspective that is not only purely morphological but also psycholinguistic. The data analyzed comes essentially from the variety spoken in Ighrem N'Ougdal area and its surroundings, a place which is largely representative of the Tashlhit language.

At the theoretical level, we will carry out our analysis under the premises of Optimality Theory (henceforth OT) (Prince and Smolensky, 1993/2004; McCarthy and Prince, 1993, 1995). We will try to present facts from the verbal and nominal morphology of the language and we will try to account for the linguistic irregularities through constraint ranking. We will resort to Correspondence Theory (McCarthy and Prince, 1995) and to Positional Faithfulness theory (Beckman, 1998) with main reference to the root morpheme to account for some aspects

of the morphological system of the language. Using the interaction between faithfulness and markedness constraints and root faithfulness constraints, we will also try to argue for the presence of vocalic elements in the root structure of Tashlhit assuming that root elements, be they vocalic or consonantal, will be preserved in the output.

At the psycholinguistic level, we will follow the assumption that linguistic phenomena are not exempt from extralinguistic factors (Berent & Shimron, 1997, 2003; Frish & Zawaydeh, 2001; Prunet, Béland & Idrissi, 2000). More specifically, we will discuss data from priming experiments, based on measuring the reaction times of the participants, to test whether roots in Tashlhit have some psycholinguistic reality and, hence, whether they have any significant implication for the organization of the Tashlhit lexicon. This type of experiment generally exposes participants to a stimulus (prime), which influences their response to a subsequent stimulus (target).

As already stated, the novelty of this dissertation is twofold: First, we will present further theoretical arguments in favor of the vocalic root in Tashlhit suggesting that the Tashlhit lexicon consists of consonantal and vocalic roots. Second, we will use psycholinguistic tests to investigate whether roots in Tashlhit constitute lexical entries in the Tashlhit mental lexicon. We will also use some priming tests to examine the effect of the root structure in language processing.

The remainder of this dissertation will be organized into five chapters. Chapter I will sketch the characteristics of the Tashlhit phonological and morphological system, on the one hand, and the root structure in Hamitic-Semitic languages, on the other. As far as Tashlhit morphology is concerned, we will present the basic facts about both verbal and nominal morphology. Each aspect or category will be defined and exemplified. In this chapter, we will also discuss the two contrasting morphological approaches: the root-based and word-based

ones. As our argumentation advocates the root morpheme, a detailed discussion on the root-based theory and its criticism is necessary.

Chapter II will present the premises on which our analyses will be based. As a reminder, our work is organized in a twofold fashion: one part will provide the theoretical analysis and argumentation for the root structure and the second will adduce external evidence for the significance of the root. In this chapter, we will, first, present an overview of the Optimality Theoretic framework, Correspondence Theory and Positional Faithfulness. Second, we will introduce the priming tests we will be using in conducting our experiments. This chapter will continue with a discussion of the different priming techniques and modalities used hitherto in the literature and justifies our choice for the speech priming or the auditory priming.

Chapter III will provide further arguments in favor of the root-based approach. We will discuss in further detail the relevance of the root in understanding the verbal and nominal morphology of Tashlhit. We will also distinguish vocalic and consonantal roots in the Tashlhit lexicon. Ample evidence will be presented in support of the bipartite system of Tashlhit roots. The cases we present in the third chapter will challenge the consonantal root in Tashlhit suggesting that a consideration of the vocalic root is necessary to understand the position of certain vowels in Tashlhit forms. We will also present a constraint-based analysis of perfective morphology and of the morphology of the construct state of Tashlhit nouns. The implications of the approach we advocate in this study will also be discussed in this chapter.

Chapter IV will be about the priming tests we conducted in the language. As we have more regular overlappings of semantics and morphology in the language, we will test the semantic priming effect in the language, and we will present the details of the methodology adopted in all the priming experiments we will use in this study. We will also present the

pretests we used to select our experimental stimuli, namely the frequency and the semantic pretests.

Last but not least, chapter V will examine the morphological priming effect as external evidence for the role of morphology in the language. For an authentic interpretation of the significance of the root in language processing, we will test the other linguistic factors (semantics and phonology) that may interfere with the root. We will also try to go further in our conception of the root structure and test the role of each root type (consonantal root and vocalic root) independently aiming to provide some psycholinguistic evidence for the two types of root structure in the language.

Finally, the general conclusion will summarize the main conclusions reached so far in this study.

CHAPTER I

TASHLHIT PHONOLOGY, MORPHOLOGY AND ROOT STRUCTURE

CHAPTER I: TASHLHIT PHONOLOGY, MORPHOLOGY AND ROOT STRUCTURE

1. Introduction

The main objective of this research is to discuss the root structure in Tashlhit. However, a discussion of the of the phonology and morphology of the language seems inescapable. With this end in view, we address three main points in this chapter: Phonology, morphology and root structure. Before we go to the specifics, we will present a succinct introduction of the language investigated.

Amazigh is one of the branches of Hamito-Semitic/Afroasiatic language family. The term Tamazight [tamaziɣt] is the Amazigh word used to refer to the language in Morocco. Geographically speaking, the language covers "all of North Africa, the Sahara, and a part of the West African Sahel" (Chaker, 2008).[3]

Native speakers of the language in Morocco comprise 26.7% of the population following the 2014 Moroccan census.[4] In Morocco, Amazigh is not restricted to only one variety but rather refers to three major ones: Tarifit in the north, Tamazight in the center and the south-east, and Tashlhit in the south-west and the High Atlas (El Mountassir, 2003; Ameur, Bouhjar & Boukhris, 2004). The three main varieties are 'united' by the formal Standard Amazigh.[5] Tashlhit is acquired as a first language at home. Native speakers of the language are either monolingual, bilingual or trilingual, the case for most youngsters nowadays, who also

[3] For more details on the Berber dialects and the corresponding areas where these dialects are spoken, see Chaker (2008).

[4] The reported results about native speakers of Amazigh in Morocco have been subject to debates among activists.

[5] Standard Amazigh has been introduced by IRCAM (L'Institut Royal de la Culture Amazighe) although the process of standardization is not complete yet. It has been taught at some primary schools in Morocco since 2003 before Amazigh has become the official language of Morocco in addition to Arabic in 2011.

speak Moroccan Arabic, Standard Arabic, and French. The language has many dialects. However, it is worth mentioning that the dialectal variation we notice in Tashlhit is not necessarily due to geographic distance; it can be found even in near areas.

The variety we are going to focus on and analyze is spoken in the region of *Ighrem N'Ougdal*, which covers a number of towns among which we cite *Agwim* and the nearby tribes: *Tamstinte* and *Tidili*.[6] *Tamstinte* consists of many small towns: *Tichekiouine*, *Aslen*, *Tadouyakhet* and others while towns in *Tidili* are *Ighourassen*, *Tigheramt*, *Igheroud* and others. Tashlhit variety we have investigated in this study is located more clearly in the maps in Figure 18.

One of the main points we will discuss in this chapter is of concerned to phonology. We will present some basic facts of the phonological system of the language. We will introduce the vocalic and consonantal inventories of Tashlhit and sketch out the common phonological processes in the language, namely pharyngealization and labial dissimilation. We will also review the main works that have examined the syllable structure in Tashlhit.

A second point that we will discuss in this chapter is about the verbal and nominal morphology of the language. We will introduce the inflections and derivations of both the verbal and nominal system. For the verbal morphology, we will exemplify the aorist form, the perfective, the negative perfective, the imperfective, the passive, the reciprocal and the causative. As for the nominal morphology, we will demonstrate action nouns and agentive nouns as they are the common ones in the language, and we will describe the main inflectional categories of the nominal form (gender, number and state).

[6] Agwim/Agouim is a village in Sous-Massa-Drâa situated between Tizi-n-Tichka and the city of Ouarzazate. It is 70 km away from Ouarzazate.

Third, we will review the major works that discussed the notion of the root in Hamitic Semitic languages. We will discuss the conundrum of morphological theory distinguishing between root-based and word-based approaches. More importantly, we will point to a basic distinction between root types in Tashlhit, consonantal and vocalic. We will define and discuss each root type per se, paving the way for our elaborate discussion in the following chapter.

This chapter will be organized into five sections. The following one will sketch the basic facts about Tashlhit phonology including the vocalic and consonantal inventories of the language. In section 3, we will discuss the the syllable structure of the language pointing to two main views, the syllabic consonant hypothesis and the epenthetic vowel hypothesis. Section 4 will present the main characteritics of Tashlhit derivational and inflectional morphology of verbal and nominal forms. In section 5, we will discuss the two approaches of morphological theory, word-based and root-based, in Amazigh and Semitic languages pointing to the main differences between the two approaches.

2. Tashlhit phonology

The consonantal and vocalic inventories below do not differ from those of other Tashlhit varieties.[7] The vocalic system of Tashlhit is simple, consisting of three main vowels (Basset, 1952; Boukous, 1987, 2009; El Moujahid, 1979; Bensoukas, 2001).[8]

[7] We should note that Tashlhit is an oral language and has no standard orthographic system. The only writing system Morocco has for Amazigh is Tifinaghe-IRCAM to write and read Standard Amazigh. Many points are raised for discussion on this matter from a sociolinguistic and language policy point of view, but we will not get into more detail on this issue, for it is beyond the scope of the present study.

[8] It is important to highlight an important point about the vocalic system of the language. Some studies argue that the schwa is an epenthetic vowel in Tashlhit inasmuch as it is the phonetic realization of syllable nuclei (Coleman, 2000). The opposing view is that the language is marked for its syllabic consonants, overriding the need of epenthetic vowels since consonants can also occupy the syllable nuclei position (Dell and Elmedlaoui, 1985, 1988).

(1) Tashlhit vocalic system

/i/ /u/

/a/

In contrast, the consonantal system is much more complex given that some consonants have their emphatic counterparts and others labialized counterparts.

(2) Tashlhit consonantal system

Labials	Dentals	Palatoalveolars	Velars	Uvulars	Pharyngeal	Laryngeals
	t tˤ		k kʷ	q qʷ		
b	d dˤ		g gʷ			
m	n					
f	s sˤ	ʃ ʃˤ		x xʷ	ħ	
	z zˤ	ʒ ʒˤ		ɣ ɣʷ	ʕ	ɦ
w	l	r rˤ	j			

In addition, each consonant has a geminate counterpart except for the laryngeal *ɦ*.[9] Some consonants may have more than one geminate counterpart and each form is attested in some particular area. The geminate correspondents of the labial *w*, the uvular *ɣ* and the dental *dˤ* may be realized as *ww* (*tawwuri* 'work') or *ggʷ* (*lggʷr* 'escape, imperf.'), *ɣɣ* (*ɣɣʷrˤdˤ* 'lay, imperf.') or *qq* (*rˤqqa* 'warm, imperf.'), and *ddˤ* (*aɣddˤarˤ* 'cheater') or *ttˤ* (*nttˤu* 'jump, imperf.'), respectively.

[9] We used an IPA system for all the symbols.

Gemination in Tashlhit may be lexical, phonological or morphological.

(3)

a- Lexical gemination

imi	'mouth'	immi	'mother'
gru	'pick'	ggru	'be the last one to arrive'
su	'drink'	ssu	'to carpet'

b- Morphological gemination

bnu	'build, aorist'	bnnu	'build, imperfective'
fl	'leave, aorist'	ffal	'leave, imperfective'
nkr	'wake up, aorist'	nkkr	'wake up, imperfective'

c- Phonological gemination

/ut + tamɣarˁt/	[uttamɣarˁt]	'hit the woman'
/t+afud+t/	[tafutt]	'small knee'
/t+ri+t+dar+s/	[triddars]	'you want to pay him/her a visit'

As is noticed, gemination is not position restricted; it may occur intervocalically, word initially or word finally. Although the three types of geminates are distinguished phonologically, they are characterized by the same phonetic realization (Lasri, 1991).

A point of interest in Tashlhit phonology concerns pharyngealization or emphasis.[10] This feature is a property of coronal consonants (El Moujahid, 1979; Elmedlaoui, 1985; Boukous, 1987; Lasri, 1991; Dell and Elmedlaoui, 1985, Bensoukas, 2001; Ridouane, 2008,

[10] We used IPA symbols to transcribe Tashlhit words.

2014, 2016). Other consonants and vowels might also surface with this feature. Therefore, pharyngealization might be either lexical (eg., *muʃʃ*ˁ 'cat') or surface as a result of pharyngeal feature spreading from a consonant or a back vowel. For instance, in the word /matˁiʃa/ 'tomato' only the coronal *t* is lexically pharyngealized. However, all the sounds surface as pharyngealized as a result of pharyngeal propagation [mˁatˁeʃˁa]) (see Ridouane 2008, 2014, 2016 for more details on this issue).

Another interesting point is about labial dissimilation. As is seen in (1), five consonants are lexically labialized, k^w, g^w, x^w, $ɣ^w$, q^w, and they all have geminate counterparts. Labial dissimilation takes place when these labialized round consonants are followed by a round vocoid (4-a) or immediately preceded by a round consonant (4-b). See the examples below.

(4)

a-	k^{w}na	'bend, Perf.'	knu	'bend, Aor.'
	g^{w}ra	'pick, Perf.'	gru	'pick, Aor.'
	g^{w}na	'sew, Perf.'	gnu	'sew, Aor.'
b-	ak^{w}i	'cross, Perf.'	uki	'cross, Aor.'
	ak^{w}r	'steal, Perf.'	ukr	'steal, Aor.'
	ag^{w}l	'hang, Perf.'	ugl	'hang, Aor.'

Labial dissimilation might also target the labial consonant *m* which dissimilates when followed by a labial consonant, specifically, when this consonant is a prefix. Consider the illustrations below from the reciprocal from.

(5)

a-	/m-ʃawarˤ/	[m-ʃawarˤ]	‘ask each other for points of view’
	/mm-zˤrˤa/	[mm zˤrˤa]	‘see each other’
	/m-ʃannaq/	[mʃannaq]	‘fight each other’
	/m-ʕawan/	[mʕawan]	‘help each other’
	/mm-rwi/	[mmrwi]	‘messed up/mixed’
b-	/m- faɦam/	[nfaɦam]	‘understand each other’
	/m-sallam/	[nsallam]	‘greet each other’
	/m-baddal/	[nbaddal]	‘changed with each other’
	/m-samaħ/	[nsamaħ]	‘forgive each other’
	/m-ħaʃʃam/	[nħaʃʃam]	‘ashamed’

This phonological process has been treated from different approaches (linear: Boukous, 1987, 2009; Elmedlaoui, 1985; non-linear: Elmedlaoui, 1992; Lasri, 1991; Optimality Theory: Bensoukas, 2001, 2014; CVCV model: Lahrouchi, 2003, 2018). For a detailed discussion on labial dissimilation in Tashlhit, see Bensoukas (2014).

3. Notes on Tashlhit syllable structure

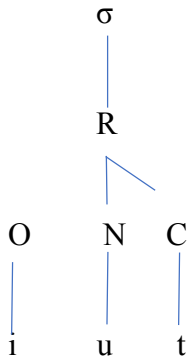
Tashlhit syllable structure has been the topic of interest of so many scholars. The language has proved to have syllabic consonants, i.e., not only can vowels occupy the syllabic position, but so can consonants. Besides, there is no restriction on syllabic consonants; all consonants have the potential to occupy the nucleus position. Hence, in the present study, we follow the assumption that the language consists of syllabic consonants leaving no option for epenthetic vowels to be called for in order to satisfy the basic syllable structure (Galand, 1988; Boukous, 1987; Dell and Elmedlaoui, 1985, 1988, 2002; Prince and Smolensky, 1993/2004;

Clements, 1997; Ridouane, 2008; Pater, 2012).[11] Before we go any further, a succinct introduction to Tashlhit syllable structure is vital.

Two main views come into play when discussing Tashlhit syllable structure: the epenthetic vowel hypothesis (Coleman, 2000; Bensoukas and Boudlal, 2012) and the syllabic consonant hypothesis (Dell and Elmedlaoui, 1985, 1988; Boukous, 1987, Prince and Smolensky, 1993/2004). We will discuss the syllabic consonant hypothesis from two different perspectives, one of which is the moraic approach to syllable structure (Jebbour, 1996, 1999). Dell and Elmedlaoui (1985, 1988) used the notion of *'core syllabification'*, which is about the construction of the core syllable (onset+nulceus). After core syllabification operates, the coda rule takes place to associate unsyllabified segments to coda position. Other rules may interfere in the operation of syllabification to get syllables matching the output form. Boukous (1987) also used core syllabification as one of the three phases proposed in the syllabification process. The major difference between the two works lies in directionality. In the process of syllabification, there might be confusing instances such as the case where we have two segments which have the same sonority value. Thus, the notion of directionality becomes important. Boukous (1987) proposes that the algorithm of syllabification operates from right to left. Boukous (1987, 2009) argues against the syllabification from left to right claiming that it produces some forms, which violate the sonority principle (eg., *a.zbg, et *n.msx), and predicts marked forms (eg., /tˤdˤmn/ 'she guaranteed', which is syllabified rightward as CCVC instead of CV.CV (leftward)). The authors add that left to right produces erroneous forms as is exemplified below in (6).

[11] In contrast, Tamazight and Tarifit resort to schwa epenthesis. For example, the verb /lmd/ is pronounced without a schwa in Tashlhit but is pronounces as /ləmd/ or /rməð/ in Tamazight and Tarifit, respectively. For more on syllable structure, see Chtatou (1991), Ameur (1986), Faizi (2002), Hdouch (2004), Bensoukas (2006/2007), among others.

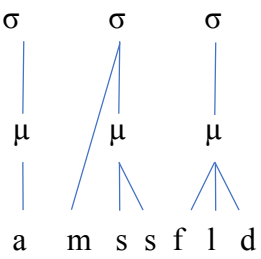
(6)

Syllabification	Directionality	Syllable structure	Output
a- Dell and Elmedlaoui (1985, 1988):	From left to right		*iwt
b- Boukous (1987):	From right to left		jut

Although Boukous' (1987) and Dell & Elmedlaoui's (1985, 1988) algorithms are different in terms of directionality, they concur on a number of points. They agree that syllables having vocalic nuclei and those having consonantal nuclei are treated the same way with respect to phonological and morphological aspects. They also agree that onsets and codas may be null, simple or complex bearing no more than two segments maximally.

From a moraic approach, the syllable structure proposed by Jebbour (1996, 1999) also makes use of the core syllable construction as a first step in the syllabification process. Then, if the unsyllabified segment is preceded by a vocalic mora, it is attached to an additional mora forming a heavy syllable. If it is preceded by a consonantal mora, it is attached to the same mora in case it is identical to the preceding one. Otherwise, it is directly attached to the syllable. Consider the following example for the sake of illustration:

(7)



To sum up, under the assumption that syllables in Tashlhit may have vocalic or consonantal nuclei (Boukous, 1987, 2009; Dell and Elmedlaoui, 1985, 1988; Jebbour, 1996, 1999 and others), the controversial idea is of concern to the difference between those syllables. Dell and Elmedlaoui (1985, 1988) and Boukous (1987) claim that there is no difference between the two types of syllable. By contrast, adopting moraic theory, Jebbour (1996) distinguishes between the two types of syllable, arguing that this difference lies mainly in syllable weight, i.e. syllables with consonantal nuclei always carry one and only one mora as opposed to syllables bearing vocalic nuclei, which may carry one or two moras maximally. Throughout this dissertation, we will adopt the latter assumption about Tashlhit syllable structure.

A challenging approach to the syllabic consonants is the epenthetic vowel (Coleman, 2000; Bensoukas and Boudlal, 2012). For instance, in the verb *kdˁu* 'smell', the cluster of consonants *kdˁ* is considered in the syllabic consonants approach as a complex onset (Dell and Elmedlaoui, 1985, 1988; Boukous, 1987; Ridouane, 2008), whereas in the epenthetic vowel approach, it is considered as having the phonological form */kədˁ/* with an epenthetic schwa filling the nucleus position (Coleman, 2000; Bensoukas and Boudlal, 2012). This approach argues for the presence of a schwa in the phonological realization of Tashlhit words. Coleman (2012) presents two main arguments for this claim. First, it contends that the epenthetic vowel yields to simple onsets rather than complex onsets, making the grammar simpler. Second, the study claims that in the recordings of a number of Tashlhit words, a variation between the

presence and absence of a vowel is observed. For instance, the verb *kdˁu* is realized as [*kdˁu*] in 2 recordings and as [*kədˁu*] in 8 recordings. However, Coleman (2000) highlights that the phonological presence of the schwa does not necessarily imply its clear phonetic realization; the schwa might be of a very short duration that makes it concealed by the neighboring consonant.[12]

Now that we have mentioned the main points on Tashlhit phonology and sketched the basic assumptions on Tashlhit syllable structure, we move to present the basic facts of Tashlhit morphology.

4. Characteristics of Tashlhit morphology

The morphological structure of Tashlhit has been treated from the structuralist approach (Boukhris, 1986; Taïfi, 1990; Boumalk, 1996), the generativist approach (Moktadir, 1989; Iazzi, 1991; Anasse, 1994) and the Optimality Theoretic approach, which focuses on universal constraints and their interaction (Bensoukas, 2001, 2010, 2016; Elazrak, 2005).[13] In this section, we will sketch some basic facts about verbal and nominal morphology of the language.

4.1.Tashlhit verbal morphology

"Tashlhit verbs agree in person, number and gender with their subjects" (Dell and Elmedlaoui, 1988, 1992, 2013). Assuming that a stem is what is left when we take agreement markers from the verbal form, we assume that Tashlhit verbs have four main stems: the aorist or imperative, the imperfective, the perfective and the negative perfective (Dell and

[12] A number of other studies claim that the syllable structure of other varieties of Amazigh (Tarifit and Tamazight) is characterized by the schwa as an epenthetic vowel that occupies the nucleus position (Kossman, 1995; Saib, 1976; Hdouch, 2004 among others).

[13] For a review of the works that deals with the verbal and nominal morphology of Tashlhit and other Amazigh varieties in detail, see Bensoukas (2006).

Elmedlaoui, 1988, 1992, 2013; Iazzi, 1991; Bensoukas, 2001, 2015; El Mountassir, 2003; Boumalk, 2004; Laabdellaoui et al., 2012). The aorist or imperative can be defined as an order, an intention, a wish, or a future. The imperfective refers to a completed action, and the perfective is used to express a current, continuous or repetitive action (Bensoukas, 2018). We will explore each of these inflectional categories per sa for the sake of their relevance to our discussion.

(8) Tashlhit perfective morphology

	Aorist	**Perfective**	**Negative perfective**
a-	nkr ‘wake up’	nkr	nkir
	mgr ‘harvest’	mgr	mgir
	frn ‘sort’	frn	frin
	krz ‘plow’	krz	kriz
b-	adr ‘pin down’	udr	udir
	ag^{w}l ‘hang’	ugl	ugil
	ak^{w}r ‘steal’	ukr	ukir
	ara ‘write’	ura	uri
c-	rar ‘give back’	rur	ruri
	zz^{ʕ}all^{ʕ} ‘pray’	zz^{ʕ}ull^{ʕ}	zz^{ʕ}ull^{ʕ}i
	ggall ‘swear’	ggull	ggulli
	mmass ‘move’	mmuss	mmussi
d-	knu ‘bend’	k^{w}na/i	k^{w}ni
	gnu ‘sew’	g^{w}na/i	g^{w}ni
	kru ‘rent’	k^{w}ra/i	k^{w}ri

ftu ‘pasture’ fta/i fti

In these examples, we notice that the negative perfective has a systematic *i* for all the verb sets. This is the negative marker in the variety of Tashlhit in addition to bound morpheme *ur* which precedes the verb. However, in other varieties of Tashlhit like that of *Agadir* and of *Ida Outanane*, a partial or a complete loss of the vocalic insertion for marking the negation has been observed. For instance, in *Ida Outanane* Tashlhit, only some verbs are subject to the loss of vocalic insertion (**ur ihddin*/*ur ihddn* ‘he did not calm down’); others are not (*ur ibni* ‘he did not build’), whreas in Agadir Tashlhit, a complete loss of negative morphology is observed (9) (Bensoukas, 2009).[14] The author has treated this issue in a number of Tashlhit varieties showing the typological variations within Tashlhit, and accounted for this “neutralization of negative morphology” through constraint interaction.

(9) Complete loss of negative morphology in Agadir Tashlhit

1 p. sg.	ur **uzi**ɣ	1 p. pl.	ur nuza
2 p. sg.	ur t**uzi**t	2 p. pl. masc.	ur t**uza**m
		2 p. pl. fem.	ur t**uza**mt
3 p. sg. masc.	ur j**uza**	3 p. pl. masc.	ur **uza**n
3 p. sg. fem.	ur t**uza**	3 p. pl. fem.	ur **uza**nt

In the affirmative form of the perfective morphology, to which we refer as perfective throughout this dissertation, we notice a vocalic alternation or ‘apophony’ for some verbs (8b, 8-c and 8-d) and not for others (8-a).[15] It is also worthy of notice that this apophony can be

[14] For more details on the variations among Tashlhit varieties with respect to negative morphology, see Bensoukas (2009).

[15] Apophony is a term used by Guerssel and Lowenstamn (1996) in dealing with the correspondence between the perfective and the imperfective morphology in Arabic. However, we use it herein to refer to the vocalic alternation in general and not, particularly, to one proposed by the authors to account for Arabic morphology.

verb initially, medially or finally. As is clearly demonstrated in (8), the *a* altenates with *u* in verb initial position (8-c) and in verb final position (8-d). However, this alternation is not always observed. Verbs with medial *u* maintain the high vowel *u* in both the aorist and the perfective (10).

(10)

Aor.	**Perf.**
dˤuf 'watch'	dˤuf
rˤuħ 'arrive'	rˤuħ
mun 'accompany'	mun
bur 'not to get married'	bur

In the perfective form, the initial and medial vowel in the data of Tashlhit we investigate herin is a high vowel *u*. However, interpreting the results is not as simple as it seems to be. In the present work, we do not assume the aorist or the perfective as bases of derivation as has been claimed in Dell and Elmedlaoui (1992) and Moktadir (1989), respectively. We focus on arguing for the presence of the vocalic elements in the root structure. hence, we will leave consideration of the apophonic variation for future research.

We also notice a final vocalic alternation in verbs in (8-d). However, we will not dwell on this point for now because we will have more to say about it in details in chapter III for it is relevant to our discussion on the root structure. We will also discuss the imperfective in a later section per sa for its relevance to our review on the debate between the root-based and word-based approaches.

In addition, other main derivational categories are relevant to the verbal morphology of the language. They are also referred to as 'secondary verbs' (Dell and Elmedlaoui, 1988, 1992,

2013). One of these categories is the causative form. Causatives are formed through the prefixation of the sibilant *s-/ss-* (Jebbour, 1996). The causative affix can be subject to assimilation in voice, place or both (Lasri, 1991; Elmedlaoui, 1992; Bensoukas, 2004a, 2012a) (11). The causative affix is also subject to a quantity alternation yielding the suffix to surface as a singleton or a geminate (Boukous, 1987; Jebbour, 1996; Iazzi, 1991; Lasri, 1991; Lahrouchi, 2003, 2013, 2018b). Hence the causative prefix has a number of allomorphs: *ss-/s-/, ʃʃ-/ʃ-, zz-/z-* and *ʒʒ-/ʒ-*.

(11) Tashlhit verbal derivations: The causative form

Underlying form	**Phonetic form**	**Type of alternation**
ss+ns	ssns ‘make sleep’	
ss+nkr	ssnkr ‘wake up sb’	none
ss+knu	ssknu ‘make bend’	
ss+nz	zznz ‘sell’	
ss+ugz	zzugz ‘descend’	Voicing
ss+zwur	zzwur ‘make first’	
ss+kʃm	ʃkʃm ‘enter’	
ss+ħʃʃm	ʃħʃʃm ‘shame’	Place: Anteriority
ss+ħuʃ	ʃħuʃ ‘make dance’	
ss+uʒʒu	ʒuʒʒu ‘make a good scent’	
ss+nʒm	ʒʒnʒm ‘save’	Both anteriority and voicing

ss+nbuʒʒr ʒnbuʒʒr ‘mess up’

The quantity of the causative prefix has been given disparate treatments in the literature. Two main streams come to play under this topic. The prefix is, underlyingly, a singleton or a geminate. From a non-linear perspective, Lasri (1991) claims that it is a simple moraic consonant which geminates in case the base to which it is associated has an initial vowel or an initial syllabic consonant. The gemination in this case abides by the Onset Principle avoiding the adjacency of two moras. This was supported by Iazzi (1991) claiming that the causative prefix is indeed a singleton and gets geminated when adjoined to bases with initial vowels, be they radical (a, u, i) or epenthetic (ə). The same hypothesis has been defended under other frameworks. Within the Government Phonology framework, Guerssel (1990) assumes that the underlying representation of the causative morpheme is {s-} and geminates to fill in the onset position. Likewise, Lahrouchi (2003) adopts a CVCV model and argues that the causative morpheme surfaces as simple [s-] when adjoined to bases having an initial CV and geminates when adjoined to CC initial bases.

Contrastively, from a prosodic perspective, Boukous (1987) argues for the geminate-underlying representation of the causative morpheme and that the degemination of the morpheme is a result of a dissimilatory process. Adopting a moraic approach, Jebbour (1996) follows the underlyingly-geminate hypothesis and contends that the morpheme degeminates when adjoined to a base having a geminate or to a base bearing more than one mora. The author adds that in the case of onsetless bases, the causative prefix maintains its geminate form to satisfy onset requirement.[16]

[16] In our presentation of the causative form, we assume that the causative prefix is a geminate.

The causative prefix might also be attached to a particular type of verbs namely quality verbs. The latter are defined semantically as a class of verbs which express the physical and moral state, physical characteristics, and colors. Morphologically, the majority of these verbs have an initial /i/ and they behave similarly to other types of verbs. Some of these verbs are exemplified in (12). For more details on quality verbs, see Boukous (1987: 540-544).

(12) Causatives derived from quality verbs

Quality verbs	**Causative**
igzal	zigzal ‘make short’
imzˤaj	simzˤaj ‘make small’
uxaj	suxaj ‘make big’
idras	sidras ‘make few’

The causative morpheme gets prefixed not only to verbal bases but also nominal bases. However, the resulting form does not necessarily get causativized, i.e. the verb form which results from the affixation of the causative prefix to nominal bases is not necessarily transitive. The causative prefix, in this case, does not play the role of a causativizer but rather that of a verbalizer. It only changes the category of the base from noun to verb. For the sake of clarity, consider the instances in (13).

(13) Tashlhit verbal derivations: The causative prefix as a verbalizer

Noun		**Verb with the causative prefix**	
udm	‘face’	ss-udm	‘kiss’
awal	‘talk’	s-awl	‘talk’
ikrkisn	‘lies’	s-karks	‘lie’
tasustit	‘sieve’	s-usti	‘sieve’

Another type of secondary verbs is the reciprocal form which is derived through the prefixation of *m-/mm-* to a verb form along with vocalic infixation. This affix has a reflexive meaning and may be realized as a geminate or a singleton as is the case for the causative prefix. The reciprocal affix may be subject to dissimilation if the word contains another labial consonant (14). In Tashlhit, the presence of two labial consonants in a word domain is banned (Boukous, 1987; Elmedlaoui, 1992; Lasri, 1991; Bensoukas, 2001, 2014; Lahrouchi, 2003, 2018b).

(14) Tashlhit verbal derivations: The reciprocal form

a-	zˤrˤ	mmzˤrˤa	‘see’
	ʕawn	mʕawan	‘help’
	rwi	mmrwi	‘mess up/mix’
b-	sllm	nsallam	‘greet’
	samħ	nsamaħ	‘forgive’
	bddl	nbaddal	‘change’

Causative and reciprocal prefixes may be conjoined in one structure. The causative form may be derived from the reciprocal and vice versa (Lahrouchi, 2003).

(15) Tashlhit verbal derivations: causative of the reciprocal

Aorist	**Reciprocal**	**Causative of the reciprocal**
knu	mmknu	smmknu ‘make two people bend towards each other’
rwi	mmrwi	smmrwi ‘mix together’
gabl	ngabal	sngabal ‘face two people together’
ħʃʃm	nħaʃʃim	snħaʃʃam ‘shame one another’

(16) Tashlhit verbal derivations: reciprocal of the causative (Lahrouchi, 2003:75)

Aorist	**Reciprocal of the causative**	
fɦm	msfiɦim	‘make people understand each other’
xdm	msxidim	‘make work’
xalf	msnxilif	‘make cross, make invert’
ħʃʃm	msniħʃʃim	‘feel ashamed together because of another person’

The passive form is another common derivational category in Tashlhit verbal morphology.[17] It is formed through the affixation of *ttu-/ttj-* along with the insertion of a prefinal/final vowel (17) (Moktadir, 1989; Jebbour, 1996; Bensoukas, 2001, 2012a, 2014, 2016). We will need to say more about the allomorphy in the passive form in the third chapter for its relevance to our discussion of the root structure.

[17] Although voice is an inflectional category, the passive form of the verb is generally discussed along with derived verbs like reciprocals and causatives.

(17) The passive form

Aorist	**Passive**	
amzˤ	ttjamazˤ	‘catch’
ag^{w}l	ttjagal	‘hang’
ak^{w}r	ttjakar	‘steal’
k^{w}rf	ttukraf	‘tie’
mgr	ttumgar	‘harvest’
mdˤlˤ	ttumdˤalˤ	‘burry’
sli	ttuslaj	‘touch’
nfi	ttunfaj	‘hide’
kmi	ttukmaj	‘smoke’

Having sketched the basic facts of Tashlhit verbal morphology, we move now to a brief review of Tashlhit nominal morphology.

4.2.Tashlhit nominal morphology

This section describes both derivational and inflectional morphology of Tashlhit nouns. We will distinguish between three main derivational noun types and three inflections. Action nouns (Act. N), agentive nouns (Ag. N) and instrument (Instr. N) or place nouns (Pl. N) are the main nominal derivations.[18] For instance, for the root √*g*^{w}*nu*, we have *tigni* as Act. N, *imgni* as Ag. N and *issgni* as Instr. N (Bensoukas, 2014). The two common categories are action and agentive nouns. Place and instrument nouns are not productive in the language. On the other hand, the three noun inflections we will briefly describe in a later section are gender, number

[18] Other categories such as names with *bu-*, *m-*, *ult-*, *war-* and *gar-* are detailed in El Moujahid (1981) and recently treated by Bensoukas (2015a-b).

and state.[19]

4.2.1. Derivational nominal morphology

Agentive nouns generally refer to the doer of the action. They have received an adequate treatment in Bensoukas (1994, 2012). They are formed through the prefixation of the inflectional morpheme {a--a} similarly to action nouns (Guerssel, 1983; Jebbour, 1991; El Moujahid, 1981; Bensoukas, 1994, 2001). This morpheme has also been referred to as the 'number marker' (Basset, 1952**;** Guerssel, 1983 and Dell and Elmedlaoui, 1992). Agentive nouns are particularly characterized by the affixation of the morpheme {m-} which is subject to labial dissimilation as is the case for the reciprocal form (Lasri, 1991; Elmedlaoui, 1992, Bensoukas, 1994, 2001, 2012b, 2014; Jebbour, 1996).[20] This is illustrated in Table 1.

Table 1: Tashlhit Agentive noun

Verb		**Agentive noun**	
		Phonological form	**Phonetic form**
a-	krz 'plow'	/a-m-kraz/	[amkraz]
	ħdˤu 'hide'	/i-m-ħdiˤ/	[imħdˤi]
	gn 'sleep'	/a-m-ggan/	[amggan]
	ni 'ride'	/a-m-naj/	[amnaj]

[19] Some nouns that also carry the inflectional morpheme are nonderived (egs., *amzˤawdˤ* 'when it's rainy and cold', *aqqur* 'noise').

[20] Some Tashlhit agentive nouns may carry the meaning of agentive nouns but are not characterized by the morpheme {m-} as in *inigi* 'a witness' and *iniɣi* 'a murdered person'. Other loans from Arabic also fall under this characterization (e.g. *axrraz* 'shoemaker', *agzzar* 'butcher') (Bensoukas, 2012b). For an exhaustive treatment of agentive nouns, see Bensoukas (1994).

b-	g^{w}mr ‘insult’	/a-m-g^{w}mar/	[ang^{w}mar]
	ag^{w}m ‘draw water from a well’	/a-m-agam/	[anagam]
	lmd ‘learn’	/a-m-lmad/	[anlmad]

Action nouns, on the other hand, have also been dealt with previously in early literature (Chaker, 1988; Saib, 1982; Guerssel, 1983; Anasse, 1994, 2005; Dell and Jebbour, 1991; Jebbour, 1991; Elmedlaoui, 1992; Bensoukas, 2001, 2010; Lahrouchi, 2013; Ben Si Said, 2014; El Hamdi, 2018). They are characterized by the morpheme {a—a} or {a—u}. In the masculine form, the initial *a* occupies word intial position, whereas the second one may be either prefinal (*aʒdar* ‘burning’) or final (*tamgra* ‘harvesting’). In the feminine form, the initial vowel *a* is posited immediately after the initial feminine marker. Anasse (2005) refers to masculine action nouns as process nouns or action nouns and to feminine nouns as instance or resultative nouns. Consider the examples in (18) of action nouns.

(18) Action nouns

Verb	**Act. N.**
rˤzˤm ‘open’	arˤzzˤum
lgr ‘lock’	talgrawt
frn ‘sort’	afran
mgr ‘harvest’	tamgra
ʒdr ‘burn’	aʒdar
nkr ‘wake up’	tankra
lwr ‘escape’	talwra

Instrument nouns and place nouns are exemplified below in (19) and (20), respectively. Their morpgological structure does not differ from that of action nouns.

(19) Instrument nouns

Verb	**Instr. N.**
krz ‘plow’	amkraz ‘tool used to plow’
sɣl ‘measure’	asɣal ‘any tool used to measure’
rbu ‘give birth’	asrbu ‘baby sling’
dl ‘cover’	isdal ‘blanket’

(20) Place nouns

Verb	**Pl. N.**
zdɣ ‘live’	amzdaɣ ‘cemetery’
adr ‘pin down’	addar ‘cowshed/pen’
sqql ‘tan on the top of the mountain’	asqqal ‘mountain’

Another category of nouns that has received special interest is referred to in the literature as bu-nouns (21).

(21)

a-	bu+agajju	buwgajju	‘strong-headed person’
	bu+aɣɣu	buwɣɣu	‘the one who sells butter-milk’
	bu+anu	buwanu	‘owner of the well’
	bu+urti	buwurti	‘owner of the orchard’

	bu+imi	bijmi	‘someone with a big mouth’
b-	bu+zzrriʕa	buzzrriʕa	‘seller of nuts/dried fruit’
	bu+ʒʒlliʒ	buʒʒlliʒ	‘layer of tiles’
	bu+ʃʃfnʒ	buʃʃfnʒ	‘doughnut seller’
c-	bu+lassˁall	bulassˁall	‘owner of the gymnasium’
	bu+labattri	bulabattri	‘drummer’
	bu+libitiz	bulibitiz	‘one who messes around’

The *bu* of bu-nouns might be attached to borrowings or native words. Bensoukas (2015a, b) defines this affix as one that “expresses the generic notion of ‘the one with X’ where X stands for any noun”. In this studies, the author has given these nouns a fully comprehensive morpho- syntactic treatment. In addition, Bensoukas (2015a, b) also points to the similar behavior of bab- and bu-. Both affxes express ownership and are attached to nouns through periphrasis and affixation, respectively. Here is an example of both cases (22) (Bensoukas, 2015,a).

(22)

		bu+tigmmi ‘house’	**Periphrastic construction**
Masc.	Sg.	butgmmi	bab n tgmmi
	Pl.	idbutgmmi	idbab n tgmmi
Fem.	Sg.	mmutgmmi	lal n tgmmi

Pl.	isttmmutgmmi	isttlal n tgmmi

idbab- and *isttlal-* are the plural forms of the periphrastic construction, and *id-* and *istt-* are the plural correspondents of *bu-*.[21]

4.2.2. Inflectional nominal morphology

Tashlhit nouns are characterized by three main inflectional categories: Gender, number and state. Singular nouns are marked with an initial vowel mostly *a-*. Other nouns are marked with initial *i-* and *u-* (*ilm* 'skin', *udm* 'face').

Plural forms are characterized by their concatnative and non concatenative morphology (Jebbour, 1988; Idrissi, 2000; Bensoukas, 2016, 2018b). They can be divided into sound (external/concatenative), broken (internal/non concatenative), and mixed (combination of both external and internal morphology) (Bensoukas, 2016). Sound plurals are the most common in Tashlhit. They are marked with the initial vowel *i-* accompanied with the suffix *–n* (23).

(23) Sound plurals

Singular		**Plural**
argaz	'man'	irgazn
aɣarˁasˁ	'road'	iɣarˁasˁn
amugaj	'cow'	imugajn
afullus	'chicken'	ifullusn
adrar	'mountain'	idrarn

Broken plurals are not subject to one systematic pattern. They are formed differently. Here are

[21] For an exhaustive treatment of bu-nouns, see Bensoukas (2015a, b)

examples for this type of plurals in (24) .

(24) Broken plurals

Sing. N.	**Pl. N.**
agadir ‘wall’	igidar
aq^{w}ʒi ‘hole'	iq^{w}ʒa
aħanu ‘small room used for food preservation’	iħuna
aglzim ‘poleaxe’	iglzam
awttˁuf ‘moth’	uwtˁfan

The third type of plurals is mixed plurals, in which both concatenative and non concatenative morphology take part. Below in (25) are illustrative examples.

(25) Mixed plurals

Sing. N.	**Pl. N.**
asrdun ‘mule’	isrdan
afud ‘knee’	ifaddn
adˁadˁ ‘finger’	idˁudˁan
afrux ‘boy’	ifrxan
azˁrˁu ‘rock’	izˁran
aslm ‘fish’	islman

For nouns with initial i- and u-, the plural forms are mostly marked with the suffix –n. However, u- initial nouns maintain the initial vowel in the plural form and do not alternate the initial vowel with *i-* (26). One explanation is that the intial vowel of u-initial nouns is lexical rather than morphological and, hence, competes with the number marker over the initial position. For a detailed discussion on the competition of lexical and morphological vowels over the initial position, see section 4 of chapter III.

(26)

Singular u-initial N.	**Plural**
udm ‘face’	udmawn
uxsas ‘head’	uxsasn
ul ‘heart’	ulawn

Another type of plurals take bound morphemes like *id-*. This type of plurals has been treated exhaustively in Bensoukas (2006, 2018b). We will cite some of the examples for the sake of completing the description of the plurals in Tashlhit. However, we will not dwell into the details of these forms in the present study.[22]

Given what has been presented on plurals, it is important to point out that plural are formed on the basis of singular forms. Hence, the vowel melody is preserved from the singular base form. We will argue in a later chapter that some of the vowels in the nominal singular form are radical for they resist to morphological process, and hence remains constant through all the derivations.

On the other hand, feminine nouns are marked with the affix t—t, distinguishing them

[22] For a recent detailed treatment of the plural forms in Tashlhit, see Bensoukas (2016, 2018b).

from masculine nouns in the singular forn. The feminine plural form, on the other hand, is marked with the prefix t-. One possible interpretation of the absence of the suffixal part of the feminine affix in plural forms is that the feminine marker is the prefix t- and not the affix t—t and that the the suffix –t serves as an epenthetic segment to fill in the empty templatic position in the masculine form (Lahrouchi, 2013).

(27)

Masculine nouns	**Feminine nouns**	
	Singular	**Plural**
argaz ‘man’	tamɣarˁt ‘woman’	timɣarˁin
afrux ‘boy’	tafruxt ‘girl’	tifrxin
asnus ‘colt’	tasnust ‘filly’	tisnusin
ajjis ‘male horse’	tajjist ‘mare (horse)’	tajjisin
asrdun ‘mule’	tasrdunt ‘mare (mule)’	tisrdan

The feminine marker is also used to express the diminutive. See the examples below for the sake of illustration.

(28)

Noun	**Diminutive form**
afud ‘knee’	tafutt
afus ‘hand’	tafust
adˁarˁ ‘foot’	tadˁarˁt
adˁadˁ ‘finger’	tadˁatt
uxsas ‘head’	tuxsast

imi ‘mouth’ timit

Action nouns are also inflected for state. They are either in their free state or construct state. Below in (29) is an exemplification of both states of the noun.

(29) Free and construct state of Tashlhit nouns

	Verb	**Action noun**	
		Free State	**Construct State**
a-	rˁzˁm ‘open’	arˁzzˁum	urˁzzˁum
	frn ‘sort’	afran	ufran
	lgr ‘lock’	talgrawt	tlgrawt
	mgr ‘harvest’	tamgra	tmgra
	ɣʷrˁsˁ ‘slaughter’	tiɣrˁsˁi	tɣrˁsˁi
b-	sawl ‘talk’	awal	wawal
	ffuɣ ‘go out’	ufuɣ	ufuɣ
	adˁn ‘ache’	attˁan	wattˁan
	ass ‘tie’	assas	wassas
	alɣ ‘compliment’	talɣat	talɣat

We will leave this point undiscussed for the time being, returning to it in section 4 in chapter III in which we will define and study the morphology of the construct state in further details.

Now, we will move to an in-depth discussion of the different views on the root-based approach and on the root structure.

5. Root Structure

The notion of the root has its origins in old treatments of the language where it is defined in the Saussurian approach as the arbitrary 'sign' which combines some sound and some meaning. Along with the traditional view, the idea that words are lexical and that they constitute the basis of derivation of other words is advocated by the 'lexicalist hypothesis' originated by Chomsky (1970). On the other hand, as an opposition to the latter claim, the decompositional theory supports the idea that words are decomposed into smaller morphological entities, the basic one being the root. In Distributed Morphology, the root has been regarded as a morpheme which differs from affixes and which lacks a 'grammatical category'. Hence, it needs to be associated to extra elements to acquire one (Halle and Marantz, 1993; Harley and Noyer, 1999; Scalise & Fabregas, 2012). In the present work, we adopt the definition of the root as the base form which cannot be further analyzed or decomposed morphologically.

The root has been widely used in Semitic and in Indo-European languages as the base of word formation. It has been advocated by the structuralist approach and has been formalized later within the autosegmental formalism, put forth by Goldsmith (1976), in which the root is represented as a separate morpheme on a separate tier (McCarthy, 1979, 1981). The basic idea in the latter approach is that roots represent the general meaning of the word whereas other linguistic components (vowels, affixes…) denote some grammatical information supporting the "root-as-morpheme hypothesis". One of the arguments in favor of the significance of the root is illustrated in the words related semantically and morphologically, in sync, claiming that these words are not randomly connected and do not exist in the language coincidentally. Examples emerge from Semitic and from Indo-European languages:

Table 2: Related words in Semitic and Indo-European languages

Language	**Root**	**Related words**
French	raison	raisonner (V) 'reason' raisonnement (N) 'reasonning' raisonnable (Adj) 'reasonable'
Italian	tem	temere (V) 'to fear' tema (N) 'fear, fearing'
Arabic	ktb	kataba (V) 'write' kitaab (N) 'book' kaatib (N) 'writer'
Hebrew	ʃmn	ʃuman (N) 'fat' ʃamen (Adj.) 'fat' hiʃmin (V) 'grow fat/ fatten'

However, the idea of having the root as an atomic unit in morphological theory has been subject to much debate in Semitic and Amazigh literature.

5.1.Root-based vs. word-based approach in Semitic languages

Word-based model and morpheme-based model are two contrasting views of morphological theory. The former suggests that the lexicon is organized through lexical entries which contains fully-specified words (Bat-El, 1994, 2003; Hammond, 1998; McCarthy and Prince, 1990; Guerssel and Lowenstamn, 1996; Ussishkin, 1999). In the morpheme-based

model, the lexicon is organized into root morphemes that relate words sharing the same morpheme (McCarthy, 1979; Tobin, 1990; Prunet, Béland & Idrissi, 2000; Rose, 2003; Arad, 2005; Twist, 2006; Gafos, 2018). A review on the debate between the two views will be detailed in what follows.[23]

5.1.1. Word-based approach

Some studies claim that Semitic languages are better explained using a word-based morphology. Bat-El (1994) argues that Hebrew verbs are formed through 'stem modification' in addition to the process of 'melodic overwriting', which assigns vowels to verbs. Ussishkin (1999) argues that Hebrew denominal verb formation is an 'output-based process' which does not resort to the notion of abstract consonantal root. Arguments come from consonantal cluster preservation and the role of the base vowel in determining the pattern of the denominal verb. In the same vein, Aronoff (1994) suggests that verb formation in Hebrew does not resort to roots. Additionally, Bat-El (2003) argues that the input is a fully specified word rather than a root. The input is selected from the surface forms in a given paradigm, and may change whenever the paradigm incurs any changes. Given the principle of "lexicon optimization", the learner selects the actual input which incurs a fewer violations of ranked constraints from all possible inputs ("richness of the base") (Prince and Smolensky, 1993/2004). Based on this, Bat-El (2003) contends that having a consonantal root as an input would incur more violations than having a word as an input. Thus, a word-to-word process is more harmonic than the root-based approach. Other arguments emerge from historical change like changes in semantic

[23] Prunet (2006) also presented a detailed review of the works on the root structure in Semitic languages and on the debate between the root-based and the word-based. The author also reviewed a number of psycholinguistic studies that are of relevance to the root morpheme.

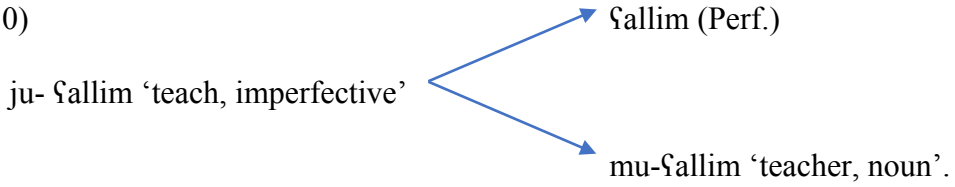
property or suppression from the language, which tend to affect all morphemic entities but not roots (Bat-El, 2003).

The morphemic status of the consonantal root has also been argued against by Ratcliffe (2004) in response to the works presented by Prunet, Béland & Idrissi (2000) and Davis and Zawaydeh (1991, 2001). Ratcliffe (2004) argues against the analyses presented in Prunet, Béland & Idrissi (2000) and Davis and Zawaydeh (2001) stating that they are confusing when it comes to the claim that the consonantal root is a morphemic entity. The author proposes that the root is a phonologically defined unit rather than a morphologically defined one, adding that the linguistic phenomena of metathesis (Prunet, Béland & Idrissi, 2000) and hypocoristics (Davis and Zawaydeh, 2001) are better explained theoretically when considering the root as a phonological unit. An alternative analysis for metathesis has been presented arguing that the domain of metathesis is defined by sonority contour rather than by the root. Ratcliffe (2004) asserts that the work presented by Davis and Zawaydeh (2001) is "contradictory", for it appeals to an output-output process to account for hypocoristics and yet, it opposes the proponents of word-based approach. The author adds that "hypocoristics are an odd place to look for evidence of morphemic segmentation. Names by their nature tend to have a unique reference." (Ratcliffe, 2004: 71).

The word-based approach has also been argued to provide an easy explanation of Arabic morphological derivations with no need to name the morpheme in question. Hammond (1988) contends that broken plurals in Arabic, formed through melodic transfer, are not based on root and template mapping. McCarthy and Prince (1990) affirms that the morphology of the reciprocal and the broken plurals is word-based rather than root-based. Furthermore, Guerssel and Lowenstamm (1996) argue for the possibility to predict the vocalic melody of one paradigm based on the vocalic melody of another, providing arguments from the perfective >

imperfective inflections. This claim proposes that only a word-to-word approach can explain the apophony proposed. Further evidence for word-based morphology is presented in Benmamoun (2003), in which passive forms are argued to rely heavily on the vocalic melody of the stative verbs and where the imperfective form is argued to be the default base of derivation of nominal derivations (except for form I) and of imperative forms as is illustrated in (30).

(30)



Benmamoun (2003) points that the formation of a paradigm is not based on the consonantal root only but also on the vocalic melody, suggesting that a root-based morphology would not explain the vocalic specification and that an important consideration of the word rather than the root is deemed necessary. However, not all imperfective-nominal derivations share the same vocalic melody. Thus, the root-based theory seems to solve the problem through mapping the root to a template with a particular vocalic melody. Hence, both approaches present their own intricacies into the grammar (Benmamoun, 2003). The root-based approach implies that there is a lack of predictability of templates whereas one of the repercussions of word-based approach is the augmentation of vocalic alternation rules, which makes the grammar more complex.

5.1.2. Root-based approach

In contrast with the word-based approach, Semitic word formation has also been treated from another perspective supporting the ‘Root Hypothesis’ (Rose, 2003; Tobin, 1990; Prunet, Béland & Idrissi, 2000; Twist, 2006; among others) arguing for the idea that pronounceable words are made of roots combined with verbal, nominal or adjectival patterns (McCarthy,

1979; Arad, 2005). Examples are in (31).

(31)

	Root	Pattern	Word
Hebrew	gdl	CaCaC (verb)	gadal ‘grow’
		CCuCa (noun)	gdula ‘grandiosity’
Arabic	ktb	CaCaCa (verb)	kataba ‘write’
		CaaCiC (noun)	kaatib ‘writer’

An argument supporting the consonantal root in Arabic comes from the language game played by Hijazi Bedouins where only root consonants are extracted and permuted. For the sake of illustration, consider the following instance from the root *dfʕ* (McCarthy, 1981):

(32)

√dfʕ	
Derived real word	**Derived permutations**
dafaʕna ‘we pushed’	daʕafna fidaʕna faʕadna ʕadafna

Prunet, Béland & Idrissi (2000) states that the metathesis produced by dyslexic participants only targets root consonants and not vowels or affixal segments. Further evidence for the morphemic status of roots in Iraqi Arabic is provided by Tucker (2010) under the premises of a root-and-prosody approach. Experimental evidence yields additional support to the

morphemic characterization of the root in Semitic languages. The root proves to facilitate lexical access in Hebrew, Arabic and Maltese, arguing for the idea that the root plays a significant role in word recognition process (Deutsch, Frost and Forster, 1997, 1998, 2000; Boudelaa and Marslen-Wilson, 2001, 2004a, 2004b, 2005; Ussishkin and Twist, 2009; Ussishkin, Dawson, Wedel & Schluter, 2015).

5.1.3. A hybrid approach: Both word-based and root-based

An alternative to the debate on the root-based and word-based morphology in Semitic languages suggests the use of both approaches for a better understanding of the linguistic system (Ethiopian Semitic: Rose, 2003, Arabic: Gafos, 2018). Under the pursuit of this proposal, other studies argue for the indirect reference to the relevance of the root as a morphemic unit.

Albeit using output-output word formation, the root has been proved to be important in the understanding of some morphological behaviors in Coptic, where the stative is formed through the infinitive with reference to the consonantal root (Kramer, 2006), and in Arabic Hypocoristics (Davis and Zawaydeh, 2001). Other arguments have been presented for the possibility of having two possible formations of agentive nouns in Modern Hebrew. They can be based on the root as they can be based on the stem (Faust and Hever, 2010: 112). The study highlights the significance of the root by claiming that "only by taking into account the root level can the behavior of agentive nouns related to the different verbs be understood as regular."

An appeal to a hybrid system in which both roots and stems come to play in the understanding of the morphological system of Semitic languages is also argued for in Schluter (2013), where a discussion about anti-root position and pro-root position is detailed. Gafos (2018) also points to the same direction and claims that both root-based and word-based

morphologies are compatible. The author explained the results of priming studies which argued for the lexical status of the root as evidence for the fact that roots are part and parcel of grammar processing rather than evidence that the grammar operates on roots.

5.2.Root-based vs. word based approach to Amazigh

The concept of the root in Amazigh has also been debated. Many morphological phenomena have been treated as word-based rather than root-based. Guerssel (1983) presents a complete rule-based analysis to the construct state of nouns with no reference to the root. It shows that the initial vowel of the stem is important in determining the behavior of the initial segment in the construct state. Within the same approach, the base of derivation of verbal morphology is not obviously known. Moktadir (1989) considers the imperative form to be the base of derivation, for it is the least marked form, whereas Dell and Elmedlaoui (1992) considers the perfective form to be the default base of other inflections: imperfective, negative, aorist. Both assumptions raise their own complexities in the grammatical system, but we will not dwell on this point for now. Additional support for the word-based approach has been presented in Bensoukas, El Hamdi and Ziani (2017) in an analysis of the morphology of French loan infinitives in Moroccan Amazigh and Moroccan Arabic, where the final vowel *i* of French infinitives is claimed to be a stem vowel. The study claims that a root-based theory does not explain why the final vowel in borrowed French infinitives (eg., *frani* 'brake', *drisi* 'tame', *galizi* 'legalize', *kunikt^{ʕ}i* 'connect', *fur^{ʕ}mat^{ʕ}i* 'format') remains constant in the perfective morphology of Moroccan Amazigh and does not ablaut, calling for a consideration that the base of derivation of the forms in question is a stem rather than a root. See the examples below for the sake illustration. (Bensoukas, El Hamdi and Ziani, 2017)

(33)

		Fr. loan inf. 'brake'	*Native verb 'go'*		
		Sg.	*Pl.*	*Sg.*	*Pl.*
1		frani-**ɣ**	**n**-frani	ddi-**ɣ**	**n**-dda
2	*Masc.*	**t**-frani-**t**	**t**-frani-**m**	**t**-ddi-**t**	**t**-dda-**m**
	Fem.		**t**-frani-**mt**		**t**-dda-**mt**
3	*Masc.*	**i**-frani	frani-**n**	**i**-dda	dda-**n**
	Fem.	**t**-frani	frani-**nt**	**t**-dda	dda-**nt**

A consideration of the processing of borrowings in tha language is an issue we leave for future research.

If the word-based approach provides a better understanding of morphological phenomena in Tashlhit, one would assume that a root-based approach is weakened and hence has no grounds in the language. However, this is not obviously true. Unlike in other languages, the root constituents may form a pronounceable entity in Tashlhit. This morphological unit has proven to be of paramount importance in the understanding of so many operations in the language (Basset, 1952; Galand, 1964/2002; Taïfi, 1990; Iazzi, 1995; Bensoukas, 1994, 2001, 2018; El Hamdi, 2018). In the next chapter, we will have more to say on this last point.

It is true that a root-based analysis has been used in several studies on Tashlhit but it is important to be aware that the root has been assigned diverse definitions in Tashlhit literature. In the imperfective morphology, where the notion of the root has been widely used, Lahrouchi (2008) considers the consonantal root (triconsonantal, biconsonantal and mono-consonantal) as a trivial morphemic unit that provides a better explanation of the imperfective. In another study, Lahrouchi (2010) proposes a binary structure of trisegmental roots where the two main

components are head and complement. The author argues that these two components are the only ones that are subject to phonotactic constraints. This analysis has been later argued against by Dell and Elmedlaoui (2013), which provides arguments from borrowed verbs as one of the idiosyncrasies posited by the head-and-complement analysis. Although the latter study explicitly states its position with regard to root-and-pattern theory inasmuch as it does not imply that Tashlhit falls under such theory, there is no denying that the root is a part and parcel of the main proposal of the study.

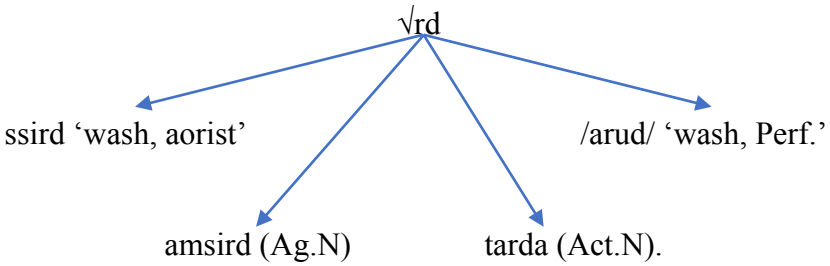
However, it is important to note that the root is viewed in Dell and Elmedlaoui (2013) as a correspondent of the aorist form of verbs. Although we agree that the aorist form might reveal some information about the root structure for some verbs, we contend that it completely misleads the conception of the root structure about other verbs. Iazzi (1991, 1995) and Bensoukas (2001, 2018) present ample facts about verbal morphology with emphasis on verbs whose root structure is not obviously retractable from the aorist form suggesting that the root is an abstract morphological unit. We will elaborate on this point in more details in the next chapter. Lahrouchi (2013) also investigates verbs with CCU and CCI structures in the aorist form but leaves whether the roots of these verbs consist of consonants only or may have vowels an open question.

For now, we will introduce the debate on the root structure in Amazigh in which two major concepts are at play: the consonantal root and the vocalic root. The consonantal root has been largely used in early Amazigh literature as a crucial lexical morpheme (Galand, 1988; Chaker, 1990; Taïfi, 1991; Lahrouchi and Ségéral, 2009; Lahrouchi, 2018a). Other studies challenge the concept of the exclusive consonantal root in Tashlhit and contend that roots in Amazigh may also consist of vowels/vocalic positions (Iazzi, 1991, 1995; Dell and Elmedlaoui, 1992, 2003; Kossmann, 1997; Bensoukas, 2001, 2018; Boumalk, 2018).

5.2.1. The consonantal root

A number of scholars have provided a set of arguments which support the consonantal root hypothesis. Evidence for this claim emerges from language games in which only root consonants are reversed, slip of the tongue in which root consonants are randomly reversed, aphasic speech and from "root extension", the operation whereby roots are subject to affixation as is the case for words and stems (Idrissi, 2001). The latter idea brings to light the 'Item-and-Arrangement' process in which consonantal roots form no exception. Another strong proponent of the consonantal root is Taïfi (1991), whose main idea is that roots are lexical entries that can be the basic form for one word or for a lexical family.

(34)



However, a root might also be the lexical entry which relates words having no semantic relation as in /s/ —> /ssu/ 'lay', /su/ 'drink'. In the same vein, Lahrouchi and Ségéral (2009) support the consonantal root hypothesis through providing facts from a secret feminine language *Taqjmit*, in which only the consonantal root is extracted to form the base of derivation and where vowels are templatic. This is exemplified in (35).

(35)

Verb	**Taqjmit form**
ɣ^{w}r ‘read’	tiɣɣarjuri
smun ‘arrange’	tissamnjumn
frħ ‘be happy’	tiffarħjurħ

Lahrouchi (2018a) extends the same idea to another type of language games in Tashlhit *Tagnawt*, in which only root consonants are subject to permutation. The author presents further evidence in support of the consonantal root from phonological constraints: labial dissimilation and anteriority assimilation. The former targets only root consonants and the presence of vowels does not target labial dissimilation even if their feature specification (labial) requires it. Examples are [**m-**sill**i****m**]→ /**n**sill**i****m**/ ‘greet each other’; [a**m-**zwar**u**]→ /a**m**zwar**u**/ ‘the first’. Anteriority assimilation, on the other hand, is subject to sibilants only; no vowel targets such process. This extends to borrowings too (from French: [sakoʃ]→ /ʃakuʃ/ ‘bag’; from Arabic: [ssfənʒ]→ /ʃʃfənʒ/ ‘donuts’; in Tashlhit: [ss-kʃm]→ /ʃʃkʃm/ ‘enter, causative’) (Lahrouchi, 2018a).

All these arguments emphasize the role of the root consonants and confirms the non-functionality of the vocalic pattern in such operations. This falls under the traditional view of the root-and-template morphology, introduced by Cantineau (1950), and later adopted in the autosegmental framework to separate roots and templates into different tiers (McCarthy, 1979, 1981).

5.2.2. The vocalic root

Although many studies support the consonantal root hypothesis, they do not necessarily reject the vocalic root hypothesis in Tashlhit. The consonantal root hypothesis generally implies that vowels have only a morphological status. However, other studies on Tashlhit reveal the opposite, suggesting that roots in Tashlhit may be composed of vowels and/or consonants. Lahrouchi (2018a) cited a few examples of verbs that raise questions about the root structure: *wala* 'follow', *warga* 'dream' and their corresponding nouns, respectively: *tawala*, *tawargit*. The author states that this type of verbs are very few and their frequency is not known; hence, they should be treated as "recalcitrant". In the present work, however, verbs with the same behavior are considered to be very intriguing and will be treated thoroughly in the third chapter.

There is precedent for the bipartition of Tashlhit roots into vocalic and consonantal in early literature. Bensoukas (2001) draws an important distinction between c-final roots and v-final roots arguing that this distinction accounts for the different behavior noticed in verbal morphology as is illustrated in (36).

(36)

	Aorist	**Perfective**	**Imperfective**
(a)	gn ‘sleep’	gn	ggan
	dˁrˁ ‘fall down’	dˁrˁ	ttˁarˁ
(b)	ls ‘wear’	lsi/a	lssa
	ns ‘spend the night’	nsi/a	nssa
(c)	knu ‘bend’	kʷni/a	knnu
	gru ‘pick’	gʷri/a	grru

In his argumentation for the consonantal root and the binary structure of roots in Tashlhit, Lahrouchi (2010) also distinguishes between verbs in (36-a) and verbs in (36-b) suggesting that the underlying structure of verbs in (36-b) have a final vocoid √*lsU*. Iazzi (1991) also argues that the type of verbs falling under the set (36-b) have an underlying vocalic segment that might be a high vowel *u*, which is no longer used in the language. Arguments for this conclusion emerge from the use of this vowel in some other Amazigh varieties (Seghrouchen, Menacer and other varieties). Indeed, presenting strong arguments in favor of the consonantal root is not sufficient to account for cases like the ones in (36-b). Ample facts from action nouns, agentive nouns and from other verbal paradigms have been presented as further arguments in favor of this distinction (Dell and Elmedlaoui, 1992; Jebbour, 1995; Iazzi, 1995; Bensoukas, 2001, 2018; Boumalk, 2018). Other studies on Tashlhit nominal morphology have raised the question about lexical and morphological vowels. Among the studies on the morphology of action nouns, Anasse (1994) conceives that a distinction between morphological vowels and lexical vowels is called for to better account for the affiliation of the initial vowel (√*amzˁ*→ /*a-ammazˁ*/ [*ammazˁ*] ‘take, Action Nouns’, √*kʃm* → /*a-kʃam*/ [*akʃam*] ‘enter, Action.N’). El

Hamdi (2018) also makes reference to the lexical vowel in a discussion on the morphology of the construct state of Tashlhit nouns in which arguments are presented for the root affiliation of the initial vowel that remains constant in the construct state of Tashlhit nouns as opposed to the morphological vowel. In the third chapter, we will have more to say on further arguments for the distinction between vocalic and consonantal roots in Tashlhit.

6. Conclusion

In this chapter, we have presented the basic facts about Tashlhit morphology, namely verbal and nominal morphology. We introduced the two major components of Tashlhit morphology: inflections and derivations of both the verbal and nominal morphology. For verbs, we defined and demonstrated the structure of the aorist, perfective, negative perfective and the imperfective forms as verb inflections, on the one hand, and we presented the basic points about causatives, reciprocals and passives as verb derivations, on the other. We also briefly described the derivational nominal categories that are common in the language: Agentive and action nouns, as well as the nominal inflections, namely, gender, number and state. A detailed discussion of the structure of these morphological components will be in Chapter III for their relevance to our discussion of the root structure.

We also reviewed the debate between the two contrasting approaches on morphological theory, word-based and root-based, and shed light on the root structure in Semitic languages and in Amazigh. We basically discussed works that supported the root morpheme, falling under the root-and-template morphology, and also the works that challenged the conception of the root in the understanding of morphology. In our discussion of Tashlhit roots in particular, we distinguished between the two types of roots we argue for throughout this work: the consonantal and the vocalic, paving the way for our discussion of the root structure in chapter III.

Now, we move to introduce some preliminaries that we will use in this study. First, we will present the theoretical framework we are adopting throughout this work and the basic assumptions upon which our analysis will be based. Second, we will sketch the basic points about the type of the psycholinguistic tests we will conduct in this study.

CHAPTER II

THEORETICAL AND EXPERIMENTAL BACKGROUND

CHAPTER II: THEORETICAL AND EXPERIMENTAL BACKGROUND

1. Introduction

This chapter will present and explain the main theoretical and experimental frameworks we will be adopting in this research. As a reminder, the main objective of this study is to provide evidence that the root is a theoretical construct that has some psycholinguistic reality. We aim to use both theoretical and empirical argumentation for that matter.

We will discuss the main assumptions that our analysis will be based on. At the theoretical level, our analysis will rely on the premises of the Optimality Theoretic approach. Correspondence Theory and Positional Faithfulness will also prove crucial to our analysis. Our analysis will be theoretically modelled through constraint interaction under standard OT. At the psycholinguistic level, we will run a set of priming experiments to investigate the psycholinguistic reality of the root as a morphemic construct.

To this end, the organization of this chapter is as follows. Section 2 will be about Optimality Theory. We will discuss the basic tenet of the theory, its architecture and its main components. Section 3 will discuss the different techniques of priming tests and also the type of test we adopted in this study. We will also discuss the priming test modality we used, and we defined the task we used in our experiments.

2. Optimality Theory

This section is devoted to the theoretical framework we adopt in this study to investigate Tashlhit root structure. It is our contention that our claim which supports the existence of abstractness in Tashlhit lexicon can be satisfactorily accounted for by computation theories like Optimality Theory (OT) and that this theory offers an appropriate analytical vessel to the

linguistic operations we discuss. Before we go into the specifics, it is important to note that we base our following discussion of the theoretical framework under the premises of parallel OT.

As a framework of linguistic analysis introduced by Prince and Smolensky (1993/2004) and McCarthy and Prince (1993a, b), OT is a constraint-based approach. It differs in various ways from earlier models in phonological theory shifting from rule-based system (SPE, Chomsky and Halle (1968)) to sets of constraints on well-formedness principles. Before OT comes to light, generative phonology has been developed through two mainstreams, the linear and the non-linear framework. The former was based on ordered rules (Chomsky and Halle (1968)), whereas the formalism of the latter framework was through phonological representations (Goldsmith, 1976; McCarthy, 1979).

Based on the linear framework, the grammar of the language is assumed to function on the basis of rules that operate in particular conditions and following particular orders. Each rule applies in a particular context, and follows or precedes another rule in order to apply to the surface structure. Consider the following rule (34) (Chomsky and Halle, 1968: 47)

(37) s → [+voice] / V_____V (voicing)

The rule (34) states that the sibilant *s* is voiced whenever it surfaces intervocalically, leading to a voicing process. Although the set of rules under this framework simplifies the operating system of the grammar, it does not present the motivations driving the phonological processes that are accounted for through rules and rule orderings. Moreover, under the linear program, phonemes or sound units are posited next to each other vertically. Thus, this framework does not account for the suprasegmental (non-linear) features like stress and syllable structure.

Later in the 70s, generative phonology has been developed and proposed a set of representations, under a non-linear program, to better picture and account for the phonological

processes in question (Goldsmith, 1976; McCarthy, 1979). This framework is different from the SPE of generative phonology in the development of multi-linear analysis, in which features and segments are represented in independent tiers which are associated with each other through association lines. Each tier differs from one another with respect to features which are specified to each single tier. For example, the Arabic verb *kataba* 'he wrote' would be represented as follows. However, the non-linear representation assumes that the universal principles are inviolable and also uses rules and features, making the grammar well represented but more condensed with information.

Optimality Theory was developed as a response to a "conceptual crisis at the center of phonological thought" (Prince & Smolensky, 1993/2004) and presents a model which relates the input to the output through constraint interaction. OT, thus, shifts focus from language specific rules to universal and violable constraints. The standard version of the theory (Parallel OT) is embodied in a set of principles, which are presented below in (38).

(38)

a- Universality

Constraints are universal

b- Violability

Constraints are violable.

c- Ranking

Constraint ranking is language specific. It denotes the hierarchy of constraints.

d- Inclusiveness

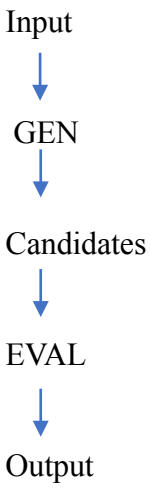
Possible analyses of the input are evaluated against the constraint hierarchy

e- Parallelism

Operations applied by GEN to get various candidates are simultaneous. No serialism as in earlier models.

Of these aspects, OT is characterized by universal and violable constraints which are subject to language particular hierarchies (rankings).

OT's architecture can be explained through the following figure: (McCarthy, 2002: 10)



GEN and EVAL, two main components of OT grammar, are responsible for determining the optimal candidate on the basis of a constraint hierarchy. For this reason, let us first elaborate on these notions. GEN (generator) has two main functions. It emits an infinite number of candidates which are related to the input in diverse ways without any restrictions. This characteristic is known as GEN's 'freedom of analysis'. GEN also specifies the relation between the input and the generated candidates. The latter are all possible analyses of the input; they are 'input dependent'. Gen is also referred to as the "operational component" (McCarthy, 2007). Second, EVAL takes over through eliminating all candidates but the one incurring the

least number of violations of the highest ranking constraint. EVAL takes into account the input, the candidates, and the constraint ranking. It is also referred to as the "constraint component" (McCarthy, 2007), which filters candidates and selects the most harmonic one with respect to the constraint hierarchy.

2.1. Constraints

According to Kager (1999), a constraint can be defined as a "structural requirement that may be either satisfied or violated by an output form". Known for their universality, constraints are expected to pertain in all languages. This is reminiscent of the notion of principles in generative grammar. However, constraints in OT are subject to violability, whereas in earlier models of grammar, we deal with parametric variation of inviolable principles.

The basic tenet of OT lies in the interaction between markedness and faithfulness constraints. Markedness constraints predict cross-linguistic unmarked phenomena. They require some well-formedness structures in the output. Unlike faithfulness constraints, markedness constraints focus on the output form regardless of the input. Instances of markedness constraints are presented below:

(39) Onset

*[σ V ('Syllables must have onsets.')

(40) NOCODA

Syllables are open.

(41) *Complex

No consonant cluster.

On the other hand, faithfulness constraints require that the features, segments and prosodic elements which pertain in the input remain as they are in the output form no matter how marked they are. In other words, elements in the output must be identical to those in the input. Faithfulness constraints preserve the lexical contrasts of the input.

The definition provided to faithfulness constraints falls under Correspondence Theory (McCarthy and Prince, 1995), a theoretical model crucial to the present dissertation. Correspondence Theory accounts for the identity between suprasegmental correspondent entities. It is defined as follows (McCarthy and Prince, 1995):

(42) Correspondence

Given two strings S_1 and S_2 , **correspondence** is a relation $\mathcal{R}$ from the elements of S_1 to those of S_2 . Elements $\alpha \in S_1$ and $\beta \in S_2$ are referred to as **correspondents** of one another when $\alpha \mathcal{R} \beta$.

Constraints on correspondent elements evaluate the correspondence and identity between the input and output, base and reduplicant, and others. A number of constraint families under the Correspondence Theory emerge as a reformulation of the P_{ARSE}-F_{ILL} faithfulness constraints under the P_{ARSE}-F_{ILL} theory. P_{ARSE} constraints militate against deletion and F_{ILL} constraints militate against epenthesis. For the sake of relevance, we will consider the following faithfulness constraints emerging from Correspondence Theory, which play a crucial role in our study:

(43) MAX-IO

Every segment of S1 has a correspondent in S2.

(44) DEP-IO

Every segment of S2 has a correspondent in S1.

(45) IDENT (F)-IO

Correspondent segments have identical values for the feature F.

One of the main constraints that our analysis will be based on is Realize Morpheme (RM). This constraint draws heavily on Kurisu's (2001) proposal and is defined in terms of output-output mapping inasmuch as it assesses the correspondence between the output and the base which may constitute the output of a bare stem. RM is defined as follows in Kurisu (2001: 39):

(46) Realize Morpheme (RM):

Let α be a morphological form, β be a morphosyntactic category, and F(α) be the phonological form from which F(α+β) is derived to express a morphosyntactic category β. Then RM is satisfied with respect to β iff F(α+β)#F(α) phonologically.

The formalization in (46) states that RM is satisfied in case a morphosyntactic category is phonologically different from the form from which it is derived, i.e. RM is satisfied as long as the candidate and the form with which it is compared are not perfectly faithful; RM is violated when the output and the base have exactly the same phonological form. For the sake of illustration, consider an example from Icelandic provided by Kurisu (2001) (47):

(47) /klifr/ Bare

[klifra] $_{\text{Infinitive}}$ # [klifr]$_{\text{Deverbal Noun}}$

√ RM

In the configuration (47), we compare the infinitive form [klifra] 'climb' with the deverbal noun [klifr] 'climbing'. The infinitive form constitutes an output$_1$ of the bare stem (input) /klifr/, and an input to the deverbal noun [klifr] (output$_2$). The situation here is of concern to output-output correspondence. RM in this case is satisfied since output$_1$ and output$_2$ are phonologically different.

RM was presented as a challenge to anti-faithfulness theory, which is also based on output-output correspondence (Alderete, 1999, 2000; Horwood, 2001; Bat-El, 2002). The idea behind anti-faithfulness theory is that, in natural languages, there is an anti-faithfulness constraint to every related faithfulness constraint (Alber & Arndt-Lappe, 2012). For instance, for MAX faithfulness constraint which militates against deletion, there is an anti-faithfulness constraint ¬MAX which favors deletion. Anti-faithfulness constraints are formulated as faithfulness constraints preceded by negation marks to oppose the corresponding faithfulness constraints.

(48) Anti-Faithfulness (Alderete, 1999, 2001)

For every faithfulness constraint *F*, there is a corresponding anti-faithfulness constraint ¬*F* that is satisfied in a string S iff S has at least one violation of *F*.

The anti-faithfulness theory operates in just surface-to-surface correspondence for no evidence has been provided to the operation of anti-faithfulness constraints in input-output correspondence (Alderete, 1999, 2001; Horwood, 2001).

Kurisu (2001) presents RM as an alternative to anti-faithfulness constraints. The author claims that anti-faithfulness constraints are always in conflict with faithfulness constraints, pointing to the fact that constraints are not always in conflict. There might be cases in which two constraints have no ranking argument and hence are not in conflict with one another. Furthermore, anti-faithfulness constraints weaken the role played by faithfulness consraints, thus, eroding of the main components of OT, markedness and faithfulness constraints. As an alternative, Kurusu (2001) proposed RM, claiming that it does not encounter the problems of anti-faithfulness theory and that it plays a role in explaining both concatenative and non concatenative morphology.

2.2.Ranking

Thus far, I have described the major types of constraints under OT. Now, focus will be on the ordering of these constraints. Unlike earlier models, OT characterizes the grammar of a language as a specific constraint ranking. Under this conception, the ordering of constraints distinguishes between different grammars. A constraint ranking may reveal the dominance relation which holds between constraints. The dominant constraint is ranked higher than the dominated constraint. In this connection, consider the following schema: C1>>C2, where '>>' denotes 'dominates'.

An important notion which requires a detailed explanation is the ranking argument. A valid ranking argument requires a conflict between the set of provided constraints. In a nutshell, constraints must disagree in the assessment of a pair of competing candidates related to the same input. Furthermore, one of the two candidates must be optimal. The following tableaux illustrate the notion of ranking argument:

(49)

Input: X	Constraint A	Constraint B
☞ Cand1		*
Cand2	*!	

(50)

Input: X	Constraint A	Constraint B
☞ Cand1	*	
Cand2	*	*

In tableau (49), the two constraints disagree in the assessment of Cand1 and Cand2. This entails that there is a conflict between the constraints and hence a ranking argument. Conversely, tableau (50) does not provide a ranking argument. Cand2 violates both constraints equally yielding no conflict between the constraints, i.e. both constraints agree in the assessment of Cand2.

Constraints can be ranked through direct or indirect ranking. In direct ranking, a constraint immediately dominates another constraint. This is the kind of interaction we have

already illustrated in (49). Indirect ranking denotes the ranking by transitivity. If CON1 dominates CON2 and CON2 dominates CON3, then CON1 dominates CON3 through indirect ranking. See the following schema for the sake of simplicity:

(51) CON1 >> CON2 ; CON2 >> CON3 → CON1 >> CON3

Worthy of comment are the multiple violations of constraints. Assuming the method of mark cancellation introduced by Prince and Smolensky (1993/2004), shared violations are ignored. To make it clearer, if two competing candidates incur the same violation (s) of the same constraint, these violations can be canceled or neglected as they do not contribute to the comparison of those candidates. "Comparison, rather than counting, is what matters" (McCarthy, 2002). For the sake of clarity, consider the following tableau (52):

(52)

Input: X	Constraint A	Constraint B
☞ Cand1	*!*!*!*!*	*!*!*
Cand2	*!*!*!*!*!*	*!*

Through the method of mark cancellation, we are left with one violation mark incurred by Cand1 with respect to Constraint B and a fatal violation mark incurred by Cand2 with respect to Constraint A. Hence, the two constraints are in conflict, i.e. tableau (52) provides a ranking argument.

Having mentioned that the constraint hierarchy of a given language denotes the grammar of that language, we assume that learning a particular grammar is, in one way or another, learning a constraint ranking. In addition, ranking permutation may yield a different

grammar. This is what is referred to as factorial typology, which constitutes one of the main characteristics of OT. It falls under the basic assumption of OT that constraints are universal and rankings are language-particular. The main idea behind factorial typology is that different rerankings of the set of universal constraints yield different grammars (languages). In other words, OT makes it possible to construct or predict a grammar out of another by the reorganization of the constraint hierarchy. However, this has been considered as a flaw to standard OT in which a wide range of possible languages predicted through factorial typology is inexistent or hard to compute, practically speaking (McCarthy, 2002; Zuraw, 2003; Ashley et al., 2010).

Optimality Theory offers a computation analytical account to a linguistic issue through tableaux. For the sake of illustration, let us consider the tableau that explains the lack of variation of nasality in vowels (total orality) in English (Kager, 1999: 37).

(53)

/pãn/	*V_{NASAL}	*V_{ORAL}	IDENT-IO (nasal)
a- pãn	*!		
b- ☞ pan		*	*

Let us first present the general organization of the tableau. The constraints are always listed at the top, ranked or ordered from left to right with the rightmost being the most dominated, and the leftmost the most dominant. The input is placed at the top leftmost corner. The candidates are listed on the left side of the tableau (53a, 53b). The star "*" denotes a violation, and if it is accompanied with an exclamation mark "*!", it signifies a fatal violation. The latter is the violation of the highest-ranking constraint which is satisfied by the optimal candidate. The latter is pointed out using the finger symbol "☞". Constraints may be separated by a solid line

denoting that there is a conflict between the constraints, as is the case for the interaction between *V_{NASAL} and *V_{ORAL}, or by a dotted line revealing that there is no dominance relation between the constraints as is demonstrated by VORAL and IDENT-IO (nasal). Shading of cells indicates that constraint violation or satisfaction has no bearing on the outcome. Of this, we say that candidate (53a) is ruled out by virtue of its fatal violation and candidate (53b) is the winner, for it satisfies the higher-ranking constraint which is violated by the competitor candidate.

2.3. Positional Faithfulness

Proposed by Beckman (1998), positional faithfulness accounts for basic asymmetries between privileged positions (root, onset…) and non-privileged ones (affix, coda…). In our discussion, we will focus on root and affix asymmetry, for it is the locus of our study. It has been proved cross-linguistically that roots exhibit more markedness than do affixes (McCarthy and Prince, 1995; Beckman, 1998; Lombardi, 1999 and others). Root and Affix asymmetry is accounted for through the universal constraint hierarchy Root Faithfulness >> Affix Faithfulness.

In her proposal, Beckman argues that roots exhibit a particular behavior regarding phonological contrasts and processes. Roots are privileged for retaining phonological contrasts which affixes and other non privileged positions seek to neutralize. Second, roots, unlike affixes, may trigger phonological processes. Third, roots are not targeted by all phonological processes, for they may show resistance to these processes. These phenomena prove that the positional privilege of roots may be accounted for through the universal hierarchy RF >> AF. Beckman (1998) provides the following ranking schema, which explains the privileged behavior of roots:

(54) IDENT-ROOT(F) » C » IDENT(F)

The phonological alternation at play (C) is outranked by the root faithfulness constraint IDENT-ROOT (F) ensuring that features are maintained in roots no matter how marked they are. On the other hand, the constraint (C) dominates the general faithfulness constraint IDENT (F), which is responsible for preserving contrasts in affixes and other positions than the roots leaving no option for phonological contrasts to surface in affixes.

This theory has already been used to explain Tashlhit data, and the anteriority assimilation of the causative prefix, in particular (Bensoukas (2004).

(55)

ss+kʃm	ʃkʃm ‘enter’
ss+ħʃʃm	ʃħʃʃm ‘shame’
ss+ħuʃ	ʃħuʃ ‘make dance’
ss+uʒʒu	ʒuʒʒu ‘make a good scent’
ss+nʒm	ʒʒnʒm ‘save’
ss+nbuʒʒr	ʒnbuʒʒr ‘mess up’

The author accounted for through the low ranking of the general faithfulness constraint IDENT (F) with regard to the root faithfulness constraint (IDENT-Root (F)), and the markedness constraint (AGREE-ANT). (Bensoukas, 2004: 143)

(56) Sibilant anteriority assimilation in Tashlhit

ss-nʒm	AGREE-ANT	IDENT-R(F)	*[-ant]	IDENT(F)	*[+ant]
a- ss-nʒm	*!		*		*
b- ss-nzm		*!		*	**
☞c- ʒʒ-nʒm			**	*	

The constraint AGREE-ANT is violated by candidate (a) since the two sibilants in the candidate do not carry the same anteriority specifications. IDENT-R(F) preserves the root constituents and hence, the output form maintains the root constituents. For having two sibilants with an [anterior] feature, the output violates the constraint *[-ant]. The output also violates the general faithfulness constraint IDENT(F) by virtue of the assimilatory process that yielded a change in the feature of the affix. Anteriority assimilation in Tashlhit provides further argument for the ranking Faith-Rt >> Faith-Aff, which turns to be of paramount importance to our analysis.

Having described the main idea behind parallel OT which provides an elegant analysis of the issues considered herein, now we turn to introduce the priming tests that we are adopting in this study.

3. Psycholinguistic approach to morphology

Psycholinguistics studies are about the language and the cognitive processes. They study how language is represented, stored and processed in the human mind. These studies expanded to semantics (Neely, 1976; Meyer, Schvaneveldt and Ruddy, 1975; McRae, De Sa, & Seidenberg, 1997; McRae and Boisvert, 1998; Moss, Ostrin, Tyler, and Marslen-Wilson, 1995;

Deutsch, Frost and Forster, 1997; Becker, 1980; Blumstein, Milberg & Shrier, 1982; Slowiaczek, 1994; Balota, 1983), phonology (Lukatela and Turvey, 1994a; Yates, Locker and Simpson, 2004; Grainger, Muneaux, Farioli and Ziegler, 2005; Kouider and Dupoux, 2005; Schluter, 2013; Halderman, Ashby and Perfetti, 2012; Radeau, Morais and Segui, 1995; Emmorey, 1989; Carreiras, 2004; Carreiras, Ferrand, Grainger and Perea, 2005; Gonnerman, Seideberg & Andersen, 2007) and morphology (Deutsch, Frost and Forster, 1998, 2000; Boudelaa and Marslen-Wilson, 2001, 2005, 2013, 2015; Schluter, 2013; Al Kaabi, 2015; Gwilliams and Marantz, 2015; Ussishkin, Dawson, Wedel & Schluter, 2015; Frost, Kugler, Deutsch & Forster, 2005). They aim to investigate the role played by semantics, phonology and or morphology in word processing. Their main objective is to examine to what extent the role played by semantics, phonology and or morphology in word recognition is significant. We will not dwell on this point in here, leaving it to chapters IV and V. Different approaches to morphology have been examined from a psycholinguistic perspective (root-based approach (Schluter, 2013; Deutsch, Frost and Forster, 1998, 2000), word-based approach (Gwilliams, Mohannan and Samuel, 2015)). In the present study, we are more interested in the role played by morphology in language processing. However, semantic and phonological factors will also be examined throughout this work.

In studies of language processing and word recognition, in particular, morphology showed to be significant in lexical access using different modalities: the visual (Boudelaa and Marslen-Wilson, 2005, 2013; Frost, Kugler, Deutsch & Forster, 2005), the auditory (Emmorey, 1989; Boudelaa and Marslen-Wilson, 2013; Schluter, 2013; Gwilliams and Marantz, 2015), and the cross-modal priming. The main objective of these works was to test how efficient the morphological theory in language process.

The strong effect played by roots in word recognition process has been demonstrated in Semitic languages and Indo-European languages. Several priming studies revealed the facilitatory role played by root morphemes in lexical access in early and late word recognition process in Arabic (Boudelaa and Marslen-Wilson, 2001, 2005, 2013; Schluter, 2013; Gwilliams and Marantz, 2015; Al Kaabi, 2015), Hebrew (Deutsch, Frost & Forster (1997), English (Emmorey, 1989; Bentin and Feldman,1990; Rastle, Davis, Marslen-Wilson and Tyler, 2000), German (Smolka, Komlosi and Rösler, 2009) and French (Longtin, Segui and Hallé, 2003; Longtin and Meunier, 2005). Yet, A complete theory on word recognition process calls for a consideration of how the mental lexicon of different languages. Hence, cross linguistic research is deemed necessary for that matter.

3.1. Priming techniques in the study of morphology

As is already mentioned, the present work discusses the concept of the root as an abstract morphological unit from a purely theoretical perspective (Chapter I and III) and from a psycholinguistic perspective (Chapter IV and V). We contend that external evidence for the root in Tashlhit will provide strong empirical arguments for our claim that the root is a lexical entry that plays an important role in Tashlhit lexical organization. Hence, we use psycholinguistic tests to this end. We particularly use priming experiments by testing aspects of word recognition. We assume that both theoretical and experimental grounds provide complete analysis of the linguistic and operational system of the language.

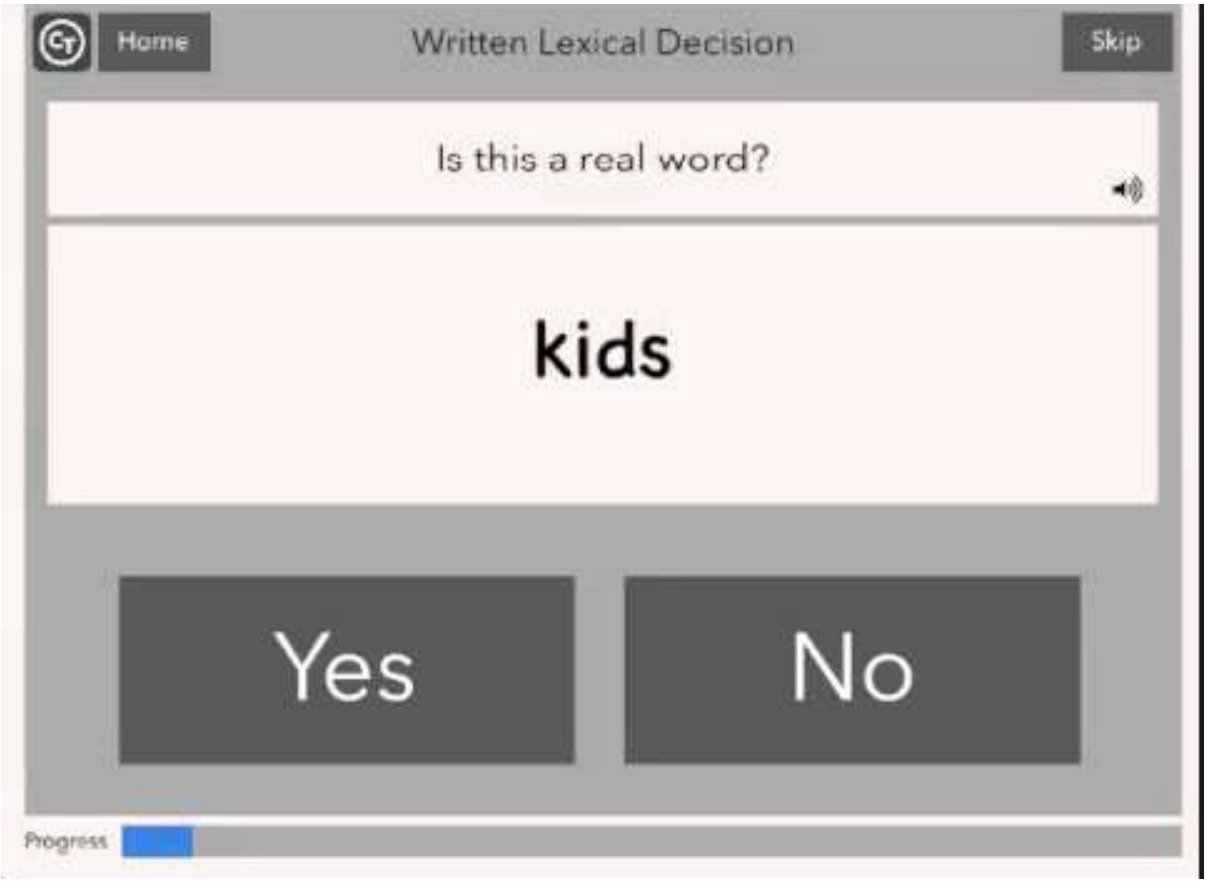
A number of studies examined different aspects of the root as a morpheme using priming tests (Boudelaa and Marslen-Wilson, 2001, 2004a,b, 2005, 2013, 2015; Frost, Kugler, Deutsch & Forster, 2005; Deutsch, Frost & Forster, 1997, 1998, 2000; Twist, 2006; Ussishkin and Twist, 2009; Ussishkin, Dawson, Wedel & Schluter, 2015; Velan and Frost, 2011; Velan, Frost, Deutsch & Plaut, 2005; Schluter, 2013). However, to the best of our knowledge, our

study is the first to approach the morphological structure of Amazigh from a psycholinguistic point of view. We will try to examine the lexicality of the root in Tashlhit and we base our study on the assumption that there is some level of mental representation of processing.

In priming experiments, we use the experimental stimuli as pairs of 'prime' and 'target'. These pairs might be real words of any morphosyntactic category (noun, verb) or nonwords (possible but non existent words in the language). The prime always precedes the target and it is either related or unrelated to the target. The latter remains constant and the variability is only subject to the prime based on the type of relation holding between the prime and target. We will base our analysis on the reaction time (RT) of the participant. The latter hears or visualizes the prime and, presumably, based on the relation between the prime and target, the participant responds faster or slower with respect to the target. If the prime facilitates the recognition of the target, the response of the participant is fast and vice-versa.

In our experiments, we will use a lexical decision task (LDT) to determine how fast the participants can classify what they hear as Tashlhit real words or nonwords (Figure 1). This technique was first introduced by Landauer and Freedman (1968) and Meyer and Ellis (1970) to classify stimuli into various categories. Then it was later referred to as 'lexical decision task' by Meyer, Schvaneveldt & Ruddy (1975) to test semantic priming showing that semantically associated words yielded fast responses of whether the word is a real word or a nonword. In a lexical decision task, the participant is asked visually or orally whether words like *cat* and *daf* are real English words or not. The correct responses would be YES and NO, respectively. In this study, we aim to converge both theoretical models of language and models of language behavior to have a better understanding of language processing. We move now to present a succinct introduction of supraliminal and subliminal priming tests, and we justify our choice of auditory modality.

Figure 1:*Written Lexical Decision Task*

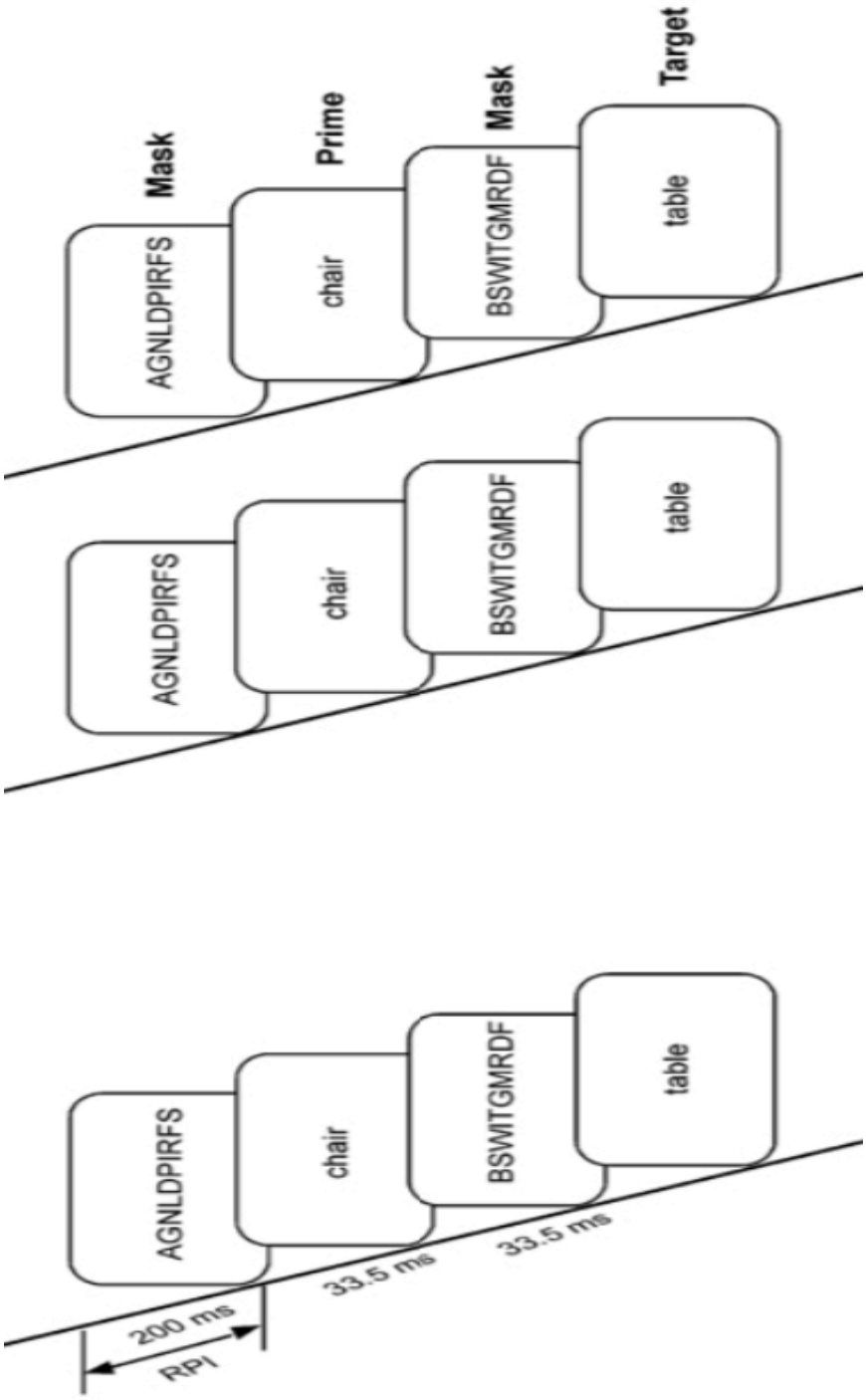


3.2. On subliminal and supraliminal priming

In priming studies, two major priming techniques are at play: subliminal and supraliminal. Subliminal priming or masked priming was developed by Forster and Davis (1984) as an experimental tool to study language processing and to investigate word recognition strategies at early stages of lexical access. The main idea of subliminal priming is the exposure of the participant to a target stimulus for processing, without his/her conscious awareness of the presence of the prime stimulus. Prime studies have shown that although the participant is unaware of the presence of the prime stimulus, the latter still proves to facilitate the target stimulus processing (Evett and Humphreys, 1981; Forster & Davis, 1984). When the prime is not available for perceptual analysis, one should conclude that priming provides strong evidence for some activation at early stages of learning (Balota, 1983).

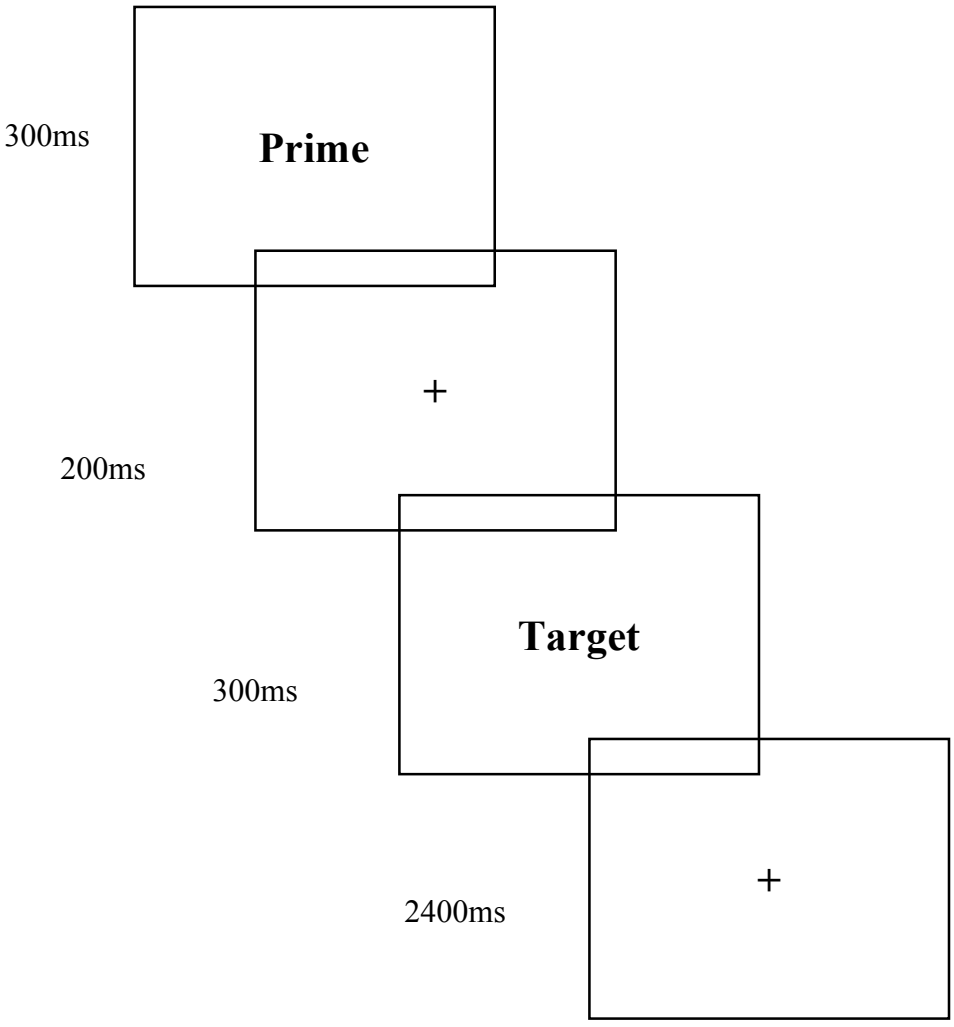
In subliminal priming, a trial generally consists of a forward mask, a prime, backward masks and the target. The prime is attenuated and compressed either to a compression rate of its original duration (eg., 35%, 40% (Kouider and Dupoux, 2005)) or to a fixed prime duration (eg., 240ms, 260ms (Schluter, 2013)). Forward and backward masks are reversed words. They are also attenuated and compressed and no mask should be a repetition of the prime or target. The target is clearly visible or heard the way it is recorded and it begins when the prime ends (Figure 2).

Figure 2: Masked/ Subliminal Priming



On the other hand, supraliminal priming or non-masked priming aims to study the late stages of language processing. In supraliminal priming tests, the participant gets exposed to a prime stimulus auditorily or visually at a long exposure duration, and it either immediately precedes the target or it precedes other interveners; then the target follows. The main idea of supraliminal priming is the conscious exposure of the participant to the prime stimulus for processing. The consciousness of the presence of prime stimuli is used as a strategy to examine lexical processing and integrative processes across words (Milin, Smolka & Feldman, 2017). In this type of experiments, only the prime and target are used; i.e., no reversed words, no masks and no compression are relevant to supraliminal priming (Figure 3).

Figure 3: Unmasked/Supraliminal priming



Priming tests in general are based on the participants' responses accuracy to targets with respect to related/unrelated prime-target pairs. The difference between the responses is what is referred to as priming effect. A fast response to the target is interpreted as a facilitatory priming effect. The present study adopts priming tests to find out if the Tashlhit lexicon consists of root morphemes, on the one hand, and to determine if other linguistic factors (phonological and or semantic) intervene with the morphological effect, if any, on the other hand.

3.3. Priming modalities: Why speech and not visual priming?

Priming tests have been used in different modalities. In the visual modality (Forster and Davis, 1984; Frost and Bentin, 1992; Deutsch, Frost and Forster, 1997, 1998, 2000; Kunde, 2004; Boudelaa and Marslen-Wilson, 2005), the prime and target stimuli are visually exposed to the participant, unlike in the auditory modality where the prime and target are auditorily exposed (Emmorey, 1989; Boudelaa and Marslen-Wilson, 2004a, 2013; Balling and Baayen, 2008; Dupoux and Mehler, 1990; Ussishkin and Twist, 2009; Gwilliams and Marantz, 2015; Gwilliams, Mohanan & Samuel, 2015; Ussishkin, Dawson, Wedel & Schluter, 2015).[24] Both visual and auditory exposure of the stimuli can be used simultaneously in an experiment and this is what is referred to as cross-modal priming (Marslen-Wilson, Tyler, Waksler & Older, 1994; Frost, Deutsch, Gilboa & Tannenbaum, 2000; Boudelaa and Marslen-Wilson, 2001, 2004b, 2015). In the present study, we use auditory modality to examine aspects of word recognition in language processing in the Tashlhit mental lexicon. The auditory modality has been used in recent studies showing significant priming effects (Maltese: Ussishkin, Dawson, Wedel & Schluter, 2015; Moroccan Arabic: Schluter, 2013).

[24] Kouider & Dupoux (2005) present a review of unfruitful previous treatments of auditory masking techniques mentioning the studies by Moore (1995) and others.

One vital advantage which is worth noticing about the auditory priming is that it gives a chance to preliterate children and illiterate adults to participate (Kouider & Dupoux, 2005), especially when the language being investigated is spoken by many illiterate participants. From a linguistic point of view, testing a language in a spoken mode is more natural than testing a language in a visual mode; the spoken mode is the first naturally acquired by children. Other than that, it is not always practical to present visual orthography of a language which has no writing system (Kouider & Dupoux, 2005; Schluter, 2013). It is true that we can use alphabets of Arabic script or the Latin script to present the orthographic structure of a word since there are participants who use such system to write the language in various situations as in text messages. However, participants may use different letters of the alphabet or a construction of two letters to present the same phoneme. For instance, we have both /r/ and /gh/ to present the phoneme /ɣ/ in Moroccan languages. Numbers are also used as one way of writing some of the phonemes. For instance, 3, 4 and 5 are used to refer to /ʕ/, /ɣ/ and /x/, respectively. Moreover, using this informal system of writing excludes illiterate participants (mainly adults) who are not to be excluded from the sample population. Other than that, in studies of the consonantal root in Hebrew and Arabic, the orthographic representation favors consonants over vowels, which may result in an overlapping with the consonantal root. Hence, the visual modality does not escape from the bias by the visual orthography (Ussishkin, Dawson, Wedel & Schluter, 2015).

4. Conclusion

This chapter presents the theoretical and experimental backgrounds of the frameworks we adopt in this study (OT and priming tests). We described Parallel OT and how it works, and we discussed its main components (constraints and ranking). In our discussion of the constraints, we introduced the basic facts of Correspondence Theory and Positional faithfulness

theory. These are the cornerstone of our analysis and are worthy of notice in this chapter. We then moved to discuss the behavioral tests we adopt in this study. We first discussed the psycholinguistic approach to linguistic studies to pave the way for the priming studies on the morphological representation in the mental lexicon. We introduced subliminal and supraliminal priming and priming modalities with main focus on the auditory priming technique or speech priming we used in our experiments. Now that the basic axioms have been laid out, we will examine the role played by roots in understanding morphological structures.

CHAPTER III

FURTHER EVIDENCE FOR THE VOCALIC ROOT IN TASHLHIT

CHAPTER III: FURTHER EVIDENCE FOR THE VOCALIC ROOT IN TASHLHIT

1. Introduction

The main objective of this chapter is to discuss the structure of the root in Tashlhit. The main issue under debate in early literature is of concern to the internal structure of the root. As we try to present further evidence for the significance of the root as a morphemic unit in Tashlhit morphology, we distinguish between two types of roots: consonantal and vocalic. The latter type of roots are the ones which consist of consonants and vowels. It is true that consonantal roots make up a large part of the Tashlhit lexicon and are even considered in some of the Amazigh literature as the exclusive type of roots in the language (Basset, 1952; Galand, 1964/2002; Taïfi, 1990, among others). However, under the exclusive consonantal root hypothesis, a number of segments remain unaffiliated and, hence, a number of morphological issues remain unexplained.

This research will contribute to the debate on the internal structure of roots in Tashlhit. The major research question we are going to answer in this chapter is whether we can achieve a complete analysis following the exclusive consonantal root hypothesis. We will provide evidence that there are certain morphological phenomena that require some other basic structure than the consonantal root to explain some of the irregularities of the linguistic system. In this study, we support the idea that the structure of roots in Tashlhit consists of vowels and consonants alike opposing the exclusive consonantality of Tashlhit roots (Dell and Elmedlaoui, 1991; Bensoukas, 2001, 2018; El Hamdi, 2018; Boumalk, 2018). The remainder of this chapter will serve to flesh out the challenges to the consonantal root in the language, and to argue that the vocalic root provides a satisfactory account of those irregularities. More details and examples are provided in the sections below.

This chapter is organized as follows. In the subsequent section, we review some of the works that argue for the vowel-final roots in Tashlhit and we support this claim through presenting additional evidence for the existence of this type of roots in the language. Section 3 continues along the lines proposed and provides additional support for the vocalic root with the main focus on the medial vowels in root structures. Section 4 argues for vowel initial roots in Tashlhit using the construct state of nouns as a case study. In these sections, we argue for the importance of the root structure in understanding verbal and nominal morphology of the language. Section 5 presents the implications of the root structure being defended in this chapter for the organization of the Tashlhit lexicon. Then we conclude.

2. Final vowels in Tashlhit root structure

In this section, we will confine ourselves to the root-final position of Tashlhit root structure. We will show the relevance of the root in understanding the morphology of Tashlhit. Our focus will be on presenting facts that lend credence to the vocalic root in Tashlhit.

2.1.Previous treatments

A detailed argumentation in support of the presence of vowels in root-final positions is provided in Bensoukas (2001):

(57)

	Aorist	**Imperfective**	**Perfective**	**Passive**	**Noun**
a-	af ‘find’	ttafa	ufi/a	ttjafa	tifi
	gru ‘pick up’	grru	g^{w}ri/a	ttg^{w}ra	tigri / imgri
	ls ‘wear’	lssa	lsi/a	ttulsa	timlsit
b-	frn ‘sort’	ffrn	frn	ttufran	afran
	fl ‘leave’	ffal	fl		
	aru ‘give birth’	ttaru	uru		arraw/tarwa

The data in (57-a) and (57-b) are distinguished in terms of their final segment. The first category (57-a) is claimed to be a set of forms whose base is vowel-final whereas the verbs in (57-b) are deemed to be forms whose base is consonant-final. Arguments emerge from the different behavior that the two categories display in different verbal and nominal classes/paradigms (Bensoukas, 2001, 2018).

The final position of verbs having a prima facie binary structure in the aorist form have been widely treated from different perspectives in the Amazigh literature.

(58)

	Aorist	**Imperfective**	**Perfective**	**Noun**
a-	ls ‘wear’	lssa	lsi/a	tilmslit
	ns ‘spend the night’	nssa	nsi/a	timnsiwin/imnsi
	k^{w}l ‘spend the day’	klla	k^{w}li/a	imlki
b-	gn ‘sleep’	ggan	gn	taguni
	fl ‘leave’	ffal	fl	
	dl ‘cover’	ddal	dl	taduli

A word-based approach would consider the base form to be the perfective form (Dell and Elmedlaoui, 1992) or the aorist form (Moktadir, 1989). We affirm that the aorist form provides no help in understanding why the two sets behave differently in verbal and nominal paradigms although they have the same binary structure. In addition, assuming that the perfective form is the base form, one of the first questions that we may ask would be of concern to the final segment/position which shows an alternation between [i] and [a] in some of the forms and no alternation in others. We will discuss the aorist and the perfective forms in more detail in subsequent sections.

Verbs behaving like *fl* ‘leave’ and *gn* ‘sleep’ are argued to have a different underlying structure from verbs like *ls* ‘wear’ and *ns* ‘spend the night’. In the Amazigh literature, it is assumed that there exists a final segment/position in the base form of these verbs, which does not surface in the aorist form. This has been dealt with differently. It is argued to be a final empty position in an abstract underlying structure (Abdelmasih, 1971; Jebbour, 1996), an empty skeletal position within the lexical entry (Iazzi, 1991), a position occupied by a ‘ghost

vowel' in the base form (Bensoukas, 1994; Iazzi, 1995) and a vocalic position filled with a low marked vowel *a* (Bensoukas, 2001, 2018).[25] Arguments for the presence of the last segment/position emerge from the verbal and nominal morphological structure presented above.[26]

It is worth reiterating that in the present work, we refer to the underlying abstract structure as the root. We follow the assumption that these verbs are underlyingly triliteral and that a final root vocalic segment a is missing in the aorist form (Bensoukas, 2001, 2018). Bensoukas (2001) accounts for the dropping of the final vowel in the aorist form through constraint interaction. The faithfulness constraints at play are MAX-u and MAX-a, which prohibit the deletion of the vowel *u* and the deletion of the vowel *a*, respectively. The markedness constraint which interacts with these faithfulness constraints is IFC (Imperative Final Consonant) which requires the final segment in an imperative form to be a consonant and not a vowel (Bensoukas, 2001). These constraints are ranked as follows to explain the imperative/aorist morphology in Tashlhit and more particularly, to account for the dropping of the final vowel *a* in the imperative form (ibid.).

(59) MAX-u >> IFC >> MAX-a

Following this ranking, verbs in the imperative form (aorist) might be either consonant final or u-final. The final vowel *a* is marked and hence does not surface when the root form has a final vowel *a*. This is supported by the fact that Tashlhit has no verbs which surface with a final *a*.

[25] The lexical entry in Iazzi (1995) is defined as :

- Prosodic template consisting of CV positions
- Melodic content (phonological traits)
- Syntactic information
- Semantic information

[26] A detailed and exemplified discussion of c-final roots and v-final roots is in Bensoukas (2001, 2018).

Only one example *ara* 'write, aorist' forms an exception to the proposal. However, this form is attested in other Tashlhit dialects as *aru* (Bensoukas, 2001, 2018).

A recent approach accounts for the dropping of the *a* in the aorist form through a 'truncation process' (Bensoukas, 2018). It is intriguing that dropping the final vowel *a* is not limited to the aorist form only. Bensoukas (2018) adds that there are other forms in some Tashlhit dialects where the dropping of the final vowel *a* is a common truncation process:

(60) i- Proper names

fatˤima	fatˤim	
xadiʒa	xadiʒ	
ii- Kinship terms		
baba	bab	'father'
immi	immi	'mother'
iii- Verbal forms		
i-ga	i-g	'he is'
i-lla	i-ll	'he is (available)'

Following the assumption that the dropping of the final vowel *a* in the aorist form is a common truncation process, we argue that this process is driven by the markedness constraint RM (Realize Morpheme) (Kurisu, 2001). In the aorist form and in the forms presented above, this constraint is satisfied by any candidate showing 'truncatory morphology' and violated otherwise. As the truncation process targets the low vowel *a* and spares the high vowels *i* or *u*,

this suggests that RM ranks higher than MAX-low vowel and ranks lower than MAX-high vowel. For the sake of exemplification, consider the tableau below which illustrates the truncation process of the final vowel in the aorist form and in other forms like proper names:

(61)

Inputs	candidates	MAX-high	RM	MAX-low vowel
/knu/	→ a- knu		*	
	b- kn	*!		
/lsa/	a- lsa		*!	
	→ b- ls			*
/ fatˤima/	a-		*!	
	→ b- fatˤim			*

Candidates with final vowel *a* in the root drop the final vowel in order to satisfy the markedness constraint RM. Their violation of the lower-ranking faithfulness constraint MAX-low vowel is not fatal. RM is violated by candidates having roots with final high vowel /*knu*/ since they do not drop the final vowel. However, they satisfy the higher-ranking constraint MAX-high vowel and hence, they surface with the final high vowel.

Other arguments supporting the final vowel in the root structure of the aforementioned verbal forms comes from the imperfective form, passive form, action nouns and agentive nouns. In the imperfective form, the final vowel is argued to be a copy of the final root vowel (Bensoukas, 2018) √*kla* → *klla* 'spend the day'; √*knu* → *knnu* 'bend'). The passive form is formed through prefinal vowel epenthesis for verbs having consonant-final roots. Verbs with vowel-final roots end with a final vowel [a] regardless of the vowel quality of their root (Bensoukas, 2001, 2018) (√*mgr* → *ttumgar* 'harvest'; √g^w*nu* → *ttg*^{w}*na* 'sew'). Action nouns and agentive nouns of verbs having a vowel-final root end mostly with a vowel (√*gru* → *tigri*

'pick up, action noun') and those of verbs having a consonant-final root end mostly with a consonant, the final root consonant (√*frn* → *afran* 'sort, action noun') (Bensoukas, 2001, 2018).[27] This set of facts turn out to be compatible with the view that the root structure (consonantal and vocalic) in Tashlhit is of crucial relevance in the understanding of verbal and nominal morphology.

In what follows, we adopt the root-based approach and will present further evidence for the presence of vocalic roots in the Tashlhit lexicon. As a matter of fact, the presence/absence of vowels in the root structure of certain verbs is not an obvious matter. Examining verbal and nominal morphology does not always help in figuring out what the root structure is. We will introduce further examples to elaborate on this point in the subsequent section. However, recall that our argumentation does not deny in any way the presence of consonantal roots in Tashlhit. Rather, it shows that both consonantal and vocalic roots constitute the Tashlhit lexicon.

2.2. Glide and high vowel alternation in i- and u- final verbs

The issue of glides and high vowels alternation has been addressed in a number of studies (Hyman, 1985; Kaye and Lowenstamm, 1984; Levi, 2008; Nevins & Chitoran, 2008; Guerssel, 1986; Rosenthall, 1994 and others). We will be concerned in this section with this type of alternation in *u*-final and *i*-final verbs in Tashlhit. To this end, we will consider the verbal and nominal morphology of these verbs. The aorist form shows a clear distinction between consonant final, *i*-final and *u*-final verbs.[28] However, we will see that the aorist form

[27] It is important, however, to note that there exist other verbs having c-final root but their action nouns end with a vowel (√mgr → tamgra 'harvest, action noun'). These vowels are accounted for in Bensoukas (2001, 2018) as templatic vowels having a fixed position.

[28] i-final vowel with c-final roots are subject to dialectal variation. In Tashlhit of Agadir and in Tashlhit of 'Ighrem nougdal', verbs like sli and zri (VI. d) are subject to vocalization of the final glide in the aorist form to get sli and zri, respectively. Other Tashlhit dialects produce the verbs in question as slj and zrj in the aorist form, with no vocalization. We will follow Bensoukas (2001) in assuming that this variation is a matter of "phonetic realization".

does not tell us much about the underlying structure of the verbs at hand (Bensoukas, 2001; Iazzi, 1995). *i*-final and *u*-final verbs show an intriguing behavior when they surface in the perfective, the imperfective form and in the nominal form, the point that questions the root structure of these verbs. Consider the data below:

(62)

	Aorist	**Perfective**	**Imperfective**	**Nominal form**
(a)	nkr ‘wake up’	nkr	nkkr	tankra (Act.N)
	lwr ‘flee’	lwr	lgg^{w}r	talwra (Act.N)
	zdɣ ‘live’	zdɣ	zddɣ	amzdaɣ ‘cemetery’
	frs ‘sharpen’	frs	ffrs	afras (Act.N)
(b)	sdu ‘lay	sdu	sdaw	asdaw (Act.N)
	nd^{ʕ}u ‘jump’	nd^{ʕ}u	ntt^{ʕ}u	tand^{ʕ}wa (Act.N)
	aru ‘give birth’	uru	ttaru	arraw/tarwa
	ttu ‘forget’	ttu	tt-ttu	
(c)	d^{ʕ}l^{ʕ}u ‘darken’	d^{ʕ}l^{ʕ}i/a	ttd^{ʕ}l^{ʕ}u	tad^{ʕ}l^{ʕ}ujji (Act.N)
	knu ‘bend’	k^{w}ni/a	knnu	tikni (Act.N)
	gnu ‘sew’	g^{w}ni/a	gnnu	tigni (Act.N)
	rbu ‘get pregnant’	rbi/a	rbbu	arbbu/asrbu ‘baby sling’
(d)	sli ‘touch’	sli	slaj	aslaj (Act.N)

	sti ‘choose’	sti	staj	astaj (Act.N)
	zri ‘pass’	zri	zraj	azzraj (Act.N)
	ɣli ‘mount’	ɣli	aqqlaj	asɣlaj ‘boiler’
(e)	ini ‘say’	nni/a	ttini	
	ili ‘be’	lli/a	ttili	
	ili ‘have’	li/a	ttili	
	iri ‘want’	ri/a	ttiri	

Verbs in set (62-a) clearly shows no vocalic pattern in the verbal morphology, suggesting the consonantal constituency of the root structure of these verbs. Their nominal paradigm exhibits systematic vocalic patterns. The latter are argued to have a fixed position in the nominal template (Bensoukas, 2001).

u-final verbs in sets (62-b) and (62-c) share the same structure CCV in the aorist form but behave differently in the perfective, the imperfective and the nominal paradigm. Bensoukas (2001: 47) suggests that the final high vowel u which does not exhibit any variation (no vowel ablaut) in the perfective form (62-b) is “a phonetic realization of an underlying glide”. We will adopt this assumption throughout this study. Further arguments in favor of this assumption emerge from the nominal forms where the glide surfaces instead of the high vowel (*tar**w**a* ‘kids’).

Interestingly, it is worth considering the alternative hypothesis which states that the underlying structure of the final segment in question is a high vowel and not a glide, and rather alternates with a glide to avoid vowel hiatus. However, this fails to explain why the high vowel

does not undergo vowel ablaut in the perfective form, as is the case for verbs in set (46-c) where verbs like *knu* and *gnu* express their perfective morphology through vowel ablaut.

We will thus base our analysis on the assumption that verbs having v-final roots surface with an *i/a* alternation ('ablaut') in the perfective form with *i* used to denote the first and second person singular and *a* for the rest, and that verbs with c-final roots do not exhibit the same behavior; they rather surface with the root final consonant (62-a) (Bensoukas, 2001, 2018; Iazzi, 1991).[29] The realization of the underlying glide as a vowel in sets (62-b) and (62-d) when they surface in the aorist form is the result of a "vocalization process" (Bensoukas, 2001, 2018).

i-final verbs in (62-d) show no vowel ablaut in the perfective morphology and exhibit a clear vowel/glide mutation in other paradigms. This behavior has been delineated in Bensoukas (2001), where the author argues that *i*-final verbs are glide-final bases (c-final roots) following Hyman (1985) and Clements and Hume (1995) in assuming that vowels and their corresponding glides share the same featural representations and that the only difference between the two lies in the feature [consonantal]. Bensoukas (2001) adds that *i*-final verbs whose root is vowel-final constitute "a lexical gap" in the Tashlhit lexicon.[30]

However, *i*-final verbs in (62-e) form counter examples to this assumption. The perfective morphology of these verbs is generated in the same way as the perfective morphology of verbs having a final high vowel in their root structure (vowel ablaut).

[29] It is important to be aware of the dialectal variation that may be subject to the perfective form as well. From a conversation with Karim Bensoukas, the verb *ndˤu* 'jump, perfective' for example is attested in other varieties (Agadir variety) as *ndˤi/a*. However, this is never the case in Tashlhit of Ighrem N'Ougdal where such verb does not ablaut in the perfective form. Yet, the verb *ndˤu* is actually a comlplicated example. Some Tashlhit varieties have *ndˤuwas* and some others have *ndˤujas*. The issue here is about the epenthetic glide which suggests a prevocalic and a postvocalic position. Future considerable research has to be devoted to such verbs.

[30] Another interesting point about the examples in (35-d) is that they mostly begin with a sibilant like the causative morpheme. They are also referred to as "pseudo-causatives". In the imperfective, they fall under the same paradigm which involves vowel insertion leading to the i/j alternation.

Bensoukas (2001, 2018) states that these verbs are intriguing in the way they behave. They behave like verbs with v-final root in the perfective morphology exhibiting vowel ablaut; yet they also behave like verbs with c-final root in the nominal morphology (*amaraj*, the agentive noun of /*iri*/ 'want' and *tillawt*, the action noun of /*ili*/ 'be'). No further explanation has been provided in any of the Amazigh literature about the underlying structure of the final segment in this set of verbs. Although these verbs are limited in number, indeed, an explanation of their behavior seems necessary. We contend that they are not some sort of ghetto in the Tashlhit lexicon but they are rather pervasive within the regular system of Tashlhit speakers.

In what follows, we try to provide more insights into this matter. The nominal morphology of verbs in set (62-e) is not well known in the Amazigh literature. It is even hard to tell for native speakers of the language. It is true that the nominal morphology provides further argumentation for the root structure. However, it consists of a large number of paradigms/templates that may be subject to verbs of the same root structure. We will exemplify this statement from verbs of consonantal roots to avoid confusion regarding the root structure.

(63)

Root	**Verb**	**Act.N**	**Ag.N**	**Place/Instrument.N**
lgr	lgr ‘lock’	talgrawt		
rzˤm	rzˤm ‘open’	arzzˤum		
ʒdr	ʒdr ‘burn’	aʒdar		
ɣʷrˤsˤ	ɣʷrˤsˤ ‘slaughter’	tiɣrˤsˤi		
stɣ	stɣ ‘crack’	asttiɣ		
ʒlx	ʒllx ‘dirty’	taʒlxijt		
rˤʃˤq	rˤʃˤq ‘have fun’	rˤʃˤuq	murˤʃˤiq	
rˤdˤl	rˤdˤl ‘lend’		arˤttˤal	
mgr	mgr ‘harvest’	tamgra	anmgar	
frg	frg ‘border’			afrig
zdɣ	zdɣ ‘live’			amzdaɣ

Given what we have stated so far, nominal templates are numerous, rendering the nominal morphology less systematic and less consistent than the perfective morphology in which the verb surfaces with no different templates for verbs having the consonantal root structure.

The point here is that perfective morphology provides stronger arguments for the root structure constituents than the nominal morphology. Going back to *i*-final and *u*-final verbs, we contend that *i*-final verbs which express the perfective morphology through vowel ablaut

(*ini*, *li*) have a final high vowel root structure and verbs which do not exhibit any final vocalic variation have consonant-final roots (*sli*, *ɣli*). This generalization suggests that *i*-final verbs having final high vowel roots do not form a lexical gap in the Tashlhit lexicon. This analysis avoids the question of what makes u-final verbs have v-final roots and c-final roots and not i-final verbs.[31] To wrap up, we argue that roots of high vowel-final verbs (both i-final and u-final) are bifurcated to final high vowel roots (v-final roots) and final glide roots (c-final roots). This makes more sense for the language to have general regularities for high vowels with no exceptional cases than having only u-final verbs with bifurcated roots and not i-final verbs as was suggested by Bensoukas (2001). Our claim suggests less markedness in Tashlhit.[32]

2.3. Formal analysis

In this section, we will try to provide an OT analysis to the perfective morphology of verbs with c-final, v-final and consonantal roots. Up to now, our discussion of these verbs suggests that high-vowel final verbs exhibit the same behavior in the verbal morphology. We investigated the perfective morphology in particular to largely draw the distinction between c-final roots and v-final roots. We extended the work undertaken in Bensoukas (2001) to claim that i-final verbs may also have roots with final vowels.

Perfective morphology exhibits different behavior for different verb categories. Verbs with consonantal roots require no change to the consonantal constituents of the root in the

[31] A further argument in favor of the presence of i-final verbs with v-final roots emerges from the imperfective morphology which distinguishes between the two cases below although the imperfective form does not always help making the distinction between v-final roots and c-final roots.

ini	'say'	vs.	ni 'ride'	aorist
nni/a			ni	perfective
ttini			ttnaj	imperfective

[32] An examination of the initial segment of these verbs (/ini, /ili/, iri) is deemed necessary to better understand the root structure of these verbs. The status of the initial vowel is not obviously known and we cannot easily claim that it is a root vowel or a morphological vowel.

perfective stem /*nkr*/ unlike verbs with glide-final roots, which resort to vocalizing the glide to form the perfective stem. Verbs with v-final roots, on the other hand, form the perfective stem through ablauting the final vowel. Given this generalization, below are the constraints that prove crucial to our analysis.

(64)

RM (Realize Morpheme)

Each morpheme in the input must have a phonological exponence in the output.

IDENT-high

Input and output correspondents must share the same feature quality.

R-ANCHOR (Root, Stem) (Bensoukas, 2001:52)

The right edge of a root must coincide with the right edge of a stem.

***μ/G**

Glides are not associated to the head mora of a syllable.

We suggest that the constraint RM drives the realization of vowel ablaut in the perfective form. RM is a high-ranking constraint allowing vowel ablaut to surface for verbs with v-final roots. Interacting with RM, IDENT-high ensures the preservation of the vowel quality from the input. Verbs with v-final roots violate this constraint to allow for vowel ablaut *i/a* driven by RM. With *i* having the [+high] feature and *a* having the [-high] feature, IDENT-high is not satisfied. This suggests the ranking RM>> IDENT-high.

We note that there is a correspondence between the final element of the root and the perfective stem in verbs having v-final roots and verbs having consonantal roots. The perfective stem ends with a vowel when the final element of the root is a vowel and ends with a consonant when the root is consonant final. Only verbs with glide-final roots do not maintain this characteristic. Thus, we adopt the anchoring constraint formulated in Prince and Smolensky (1995) and reformulated in Bensoukas (2001).

If R-ANCHOR is obeyed, the right edge of the root should coincide with the right edge of the stem. The constraint preserves the final vocalic and consonantal position of the roots in question in the perfective stem. This constraint is violated by verbs with glide-final root by virtue of the vocalization process that the dialect of Tashlhit of *Ighrem N'Ougdal* undergoes in the perfective form. This suggests that R-ANCHOR is a dominated constraint.

Perfective stems in Tashlhit of *Ighrem N'Ougdal* do not surface with final glides. It is worth noting that the alternation of underlying glides with glides or vowels is in accordance with the lexical approach (Guerssel, 1986). The latter states that the need for an underlying high vowel/glide contrast is necessary. This approach contends that underlying vowels surface as vowels whereas underlying glides may surface as glides or vowels. In the variety we investigate, we claim that this distinction between high vowels and glides apply to Tashlhit of *Ighrem N'Ougdal.* Hence, the language has lexical glides and lexical high vowels.

We attribute the absence of glides in the final position of perfective stems to the non association of glides "to the head mora of a syllable" as an effect of the constraint *μ/G (Bensoukas, 2001: 63). Given the facts presented by the language, this constraint is a higher-ranking constraint suggesting the ranking: *μ/G >> R-ANCHOR. As a result, the ranking schema for the constraints hierarchy that explains the perfective morphology in Tashlhit with

vowel-final roots, glide final roots and consonant-final roots is illustrated in the following tableaux.

(65) Perfective morphology of the verb *ili* 'have'

/li, perf./	*μ/G	R-ANCHOR	RM	IDENT-high
→ a- li/a				*
b- li			*!	

The root presented as the input in this tableau is assumed to be a v-final root. The winner is the candidate that exhibits vowel ablaut as it satisfies the high-ranking constraint RM. It violates IDENT-high because it surfaces with a low vowel a. However, its violation is not fatal. Verbs with glide final roots are exemplified below.

(66) Perfective morphology of the verb *sri* 'lick'

/srj, perf./	*μ/G	R-ANCHOR	RM	IDENT-high
a- sri/a		*		*
→ b- sri		*		
c- srj	*!		*	

The candidate showing vowel ablaut in final position is ruled out by virtue of its violation of the ANCHOR constraint which is higher ranked than the markedness constraint RM that drives vowel ablaut. It also violates IDENT-high for using a low vowel. Although this constraint is ranked lower, it makes room for the candidate with a vocalized glide to win over the one showing vowel ablaut. The fully faithful candidate to the input incurs a fatal violation of the higher ranked constraint *μ/G and is hence discarded from the set of competing candidates.

Verbs with consonantal roots maintain the consonantal constituents of the root and add no vocalic element to form the perfective stem. In standard OT terms, the output in this case violates the markedness constraint RM since the output remains faithful to the input. The candidate showing vowel ablaut as is the case for verbs with v-final roots violates the R-ANCHOR constraint, which requires the candidate to end with a consonant as in the input.

(67) Perfective morphology of the verb *nkr* 'wake up'

/nkr, perf./	*μ/G	R-ANCHOR	RM	IDENT-high
→ a- nkr			*	
b- nkri/a		*!		

It is worth reiterating that the distinction being drawn between verbs with i-final roots and verbs with c-final roots also applies to u-final verbs (46-b and 46-c). As is mentioned earlier, verbs with final high vowels are subject to the same generalization. They both have roots with final vowels and roots with final consonants/glides. As is the case for *i*-final verbs, in the perfective form, *u*-final verbs surface with a final vocalized glide when the verb has a glide-final root (*ndˤu* 'jump', *aru* 'give birth') and undergo vowel ablaut in the opposite case (*knu* 'bend', *gnu* 'sew') (46-b and 46-c).

Now that we attested that *i*-final verbs in Tashlhit may have roots with a final vowel (46-e), we will provide more insights to other vocalic positions in the root structure of Tashlhit. Not only final position might be occupied with a vowel but also the medial and the initial position.

3. Medial position in Tashlhit roots

This section will introduce a set of verbal forms and their corresponding nominal derivations that can be adduced to exemplify the distinction between roots with medial vowels and roots with medial consonants.

(68)

	Aorist	**Perfective**	**Imperfective**	**Noun**
(a)	xtm ‘complete (esp for Quran)’	xtm	ttxtam	xatima
	zhr ‘have fun/dance’	zhr	ttzhar	
	ħfr ‘kick sb out’	ħfr	ttħfar	aħfur
	brˁm ‘roll’	brˁm	ttbrˁam	abrˁam/brˁim
	lˁbˁʒˁ ‘crash’	lˁbˁʒˁ	ttˁlˁbˁaʒˁ	alˁbˁaʒˁ
(b)	zzˁallˁ ‘pray’	zzˁullˁa/i	ttzˁallˁa	tazˁallˁit
	ggall ‘swear’	ggulla/i	ttgalla	tagallit
	rar ‘give back’	rura/i	ttrara	iraran
	ttˁaf ‘carry’	ttˁaf	tt-ttˁaf	
	qqar ‘be hard’	qqur	ttqqur	taqqart/taqqurt
	wala ‘follow’	wala	ttwala	tawala
	wwarg ‘dream’	wwarga	ttwarga	tawwargit

	sawl ‘speak’	sawl	sawal	awal
(c)	dˁuf ‘watch over’	dˁuf	ttdˁuf	
	rˁuħ ‘arrive’	rˁuħ	ttrˁuħ	
	luħ ‘throw’	luħ	ttluħ	
	mun ‘arrange’	mun	ttmun	tamunt/asmun
	bur ‘don’t get married’	bur		anbur

A quick glance at the data shows that the first dataset exemplifies forms derived from consonantal roots (68-a). The aorist and the perfective forms of these verbs show no vocalic melody unlike the verbs in sets (68-b) and (68-c). The imperfective form in the examples presented above is formed through tt-prefixation.[33] Data like these have been given disparate treatments in the literature (Chaker, 1997; Dell and Elmedlaoui, 2013; Iazzi, 1991; Jebbour, 1991, 1996; Boukous, 2009; Lahrouchi, 2008, 2010; Bensoukas, 2001, 2018). However, a few studies have discussed the medial vowel in forms like these. In this section, we will focus on the medial vowel which constantly surfaces in all the verbal and nominal forms. Before we turn to the specifics, it is worthwhile to look at the imperfective form in Tashlhit in a nutshell for it constitutes a key element that should not go unnoticed when discussing the root structure.

3.1. Note on the imperfective form

Another common way to form the imperfective in Tashlhit than *tt*-prefixation and or the insertion of a vowel is through gemination (*kkrz* ‘plow’, *nkkr* ‘wake up’). This has been

[33] It is common that the tt-prefixation can form the imperfective on its own (tt-ttu ‘forget, imperfective’) as it may be accompanied by the insertion of a prefinal or a final vowel (tt-ħfar ‘kick sb out, impefective’, tt-rara ‘throw up/give back’). More details about the morphology of the imperfective in Tashlhit are presented in the subsequent section.

accounted for through syllable structure in syllable-based approaches (Dell and Elmedlaoui, 1985, 1991, 2013; Jebbour, 1996) and through root structure (Lahrouchi, 2010; Bensoukas, 2001, 2018). Although these works have used the notion of the root as part and parcel of their analysis, it is important to be aware of the fact that they use different conceptions of the notion of the root. To avoid misleading conceptions, we recall that the root in our study is considered to be an abstract form that might be consonantal or vocalic, consisting of one or more vowels.

In his reference to the base as an abstract form, Bensoukas (2001, 2018) suggests a different account to the imperfective form by stating that tt-prefixation selects verbs with vowel initial and vowel medial bases and that gemination is most likely associated to bi- or triliteral consonantal bases and also vowel final bases. In one way, this is similar to Dell and Elmedlaoui's (2013) view. However, the two approaches adopt different definitions of the base form. Dell and Elmedlaoui (2013) assumes that the aorist form and the root are interchangeable whereas Bensoukas' (2001, 2018) approach defines the base as an abstract form. As a reminder, we have argued, that the aorist form does not tell much about the structure of the root. We attest that the latter is rather an abstract form which explains some of the irregularities we notice in the verbal and nominal morphology of the language.

In addition to what has been claimed in Bensoukas (2001, 2018), other representative cases of tri-consonantal verbs, including borrowings (68-a) and v-final bases, may take tt-prefixation to form the imperfective. Consider the verbs below in (69) for the sake of illustration.

(69)

	Aorist	**Perfective**	**Imperfective**	**Noun**
a-	ggru ‘arrive last’	gg^{w}ri/a	tt-gru	Amggaru
	kk ‘visit’	kki/a	tt-kka	
b-	dʕu ‘pray for’	dʕi/a	tt-dʕu	dduʕa
	rˤʒˤu ‘hope’	rˤʒˤi/a	tt-rˤʒˤu	rrˤʒˤa
	ʕfu ‘recover/forgive’	ʕfi/a	tt-ʕfu	lʕfu
	rˤdˤu ‘accept/ bless’	rˤdˤi/a	tt-rˤdˤu	rrˤdˤa

Indeed, this data needs further investigation and the imperfective as a whole is not an easy matter to deal with. The point here, in this section, is to show that the notion of the root has been used under different conceptions to account for the imperfective form in Tashlhit. Hence we should have explicitly reiterated our conception of the root with emphasis on the importance of the root structure. We will give further evidence for that matter in what follows.

3.2. Where does the medial vowel come from?

We will now provide further grounds for challenging the consonantal root in Tashlhit. Going back to the data in (68), an obvious distinction can be made between the first set (68-a) and the subsequent sets (68-b) and (68-c). We take the aorist form as our starting point. Assuming that roots have no vowels in the medial position in Tashlhit root structure, what would motivate the presence of a medial vowel in some aorist forms (/*ggall*/, /*mun*/) and not into some others (/*zhr*/, /*gn*/)? It is of interest to notice that verbs in sets (68-b) and (68-c)

surface with a low vowel and a high vowel, respectively, which makes it even more complicated in assuming that the vowels in question are morphological.

The presence of the medial vowel in the forms at hand might be due to different reasons. We name augmentation as one of them. This process is motivated in some languages by "syllable weight, tone, and (low-sonority onsets)" (Smith, 2000), none of which occurs in the cases above. In addition, examples of binary structures are common in the Tashlhit lexicon (*zzˤlˤ* 'lay', *gn* 'sleep', *dl* 'cover', *dˤrˤ* 'fall down', and *fl* 'leave'). This leaves the option of augmentation through the addition of a vowel to the forms in question superfluous and unmotivated.

Another option is that the medial vowel at hand is 'templatic'. However, the persistent occurrence of this vowel in both verbal forms and nominal forms leaves the particularity of this vowel ambiguous: is it a constituent of a verbal template or a nominal one? Moreover, the presence of both a low vowel and a high vowel questions the systematic vocalic template. Note that the difference in vowel quality cannot be due to phonological reasons. This makes us ponder over the assumption we made earlier about the consonantality of the root structure of these verbs in Tashlhit. Bensoukas (2018) adds that a consonantal root-based approach would require "a huge amount of lexical, idiosyncratic information carried out by the templates".

Had we claimed that the vowels in question are radical, we would have avoided the obvious pitfalls. A consideration of this alternative would give solid grounds to distinguish between the roots of verbs like *zzˤlˤ* 'lay' and *zzˤallˤ* 'pray' which would clearly have consonantal and vocalic roots, respectively. Given what has been said so far, the position I take here is that Tashlhit root structure might have roots with vowels in the medial position.

4. V-initial roots in Tashlhit

So far, we have argued that the root in Tashlhit may be consonantal or vocalic having a vowel in final or medial positions. In this section, we will continue along these lines and extend our discussion to the initial position in Tashlhit root structure. To this end, we will use the construct state (CS) of Tashlhit nouns to draw the distinction between v-initial roots and c-initial roots in Tashlhit (El Hamdi, 2018).

4.1. What is the Construct state of Tashlhit nouns?

The CS of Tashlhit nouns has been exhaustively studied in the Amazigh literature (Applegate, 1958; Abdel-Massih, 1971; Saib, 1982; Guerssel, 1983; Brugnatelli, 1987, 1997; Chaker, 1988; Vycichl, 1989; Dell and Jebbour, 1991; Jebbour, 1991; Elmedlaoui, 1992; Bensoukas, 2001, 2010; Lahrouchi, 2013; El Hankari, 2014; Ben Si Said, 2014; El Hamdi, 2018). Before we go to the specifics, we will present a succinct definition of the CS in Tashlhit. A noun is in the CS when it functions as: (El Hamdi, 2018)

(70)

a- The subject of a preceding verb:

i- smun **ufruɣ** kra n iẓṛan

he gather-perfective boy-CS some of stones

'The boy gathered some stones'

b- The object of a preposition

- i dda s ugdal

he go-perfective to Agdal-masculine-CS

‘he went to Agdal’

- i dda s tgmmi

  he go-perfective to home-feminine-CS

  ‘he went home’

c- The complement of a noun

  sˤsˤẒṛt n **wargan**

  the tree of argan nut-masculine-CS

  ‘the argan tree’

d- The complement of a quantifier

- **jan urgaz**

  one man-CS

  ‘one man’

- jat **tmɣart**

  one woman-CS

  ‘one woman’

The initial segment of Tashlhit nouns demonstrates particular patterns in the CS. Before elaborating, it is important to note that we assume that the CS affix is an initial *u*.

In early Amazigh literature, the CS affix was claimed to be a high vocoid /U/ whose surface vocalic or consonantal structure is dependent of its syllabic position in masculine nouns. Feminine nouns, on the other hand, are marked with the absence of the CS affix (Guerssel, 1983; Jebbour, 1991; Dell and Jebbour, 1991). Examples of the CS and the Free state (FS) or the unmarked state are demonstrated below.

(71)

	FS singular	**CS singular**	**FS plural**	**CS plural**
		- **Masculine Nouns**		
a-	amugaj ‘bull’	umugaj	imugajn	jmugajn
	igrtil ‘strawmat’	jgrtil	igrtal	jgrtal
b-	adˤʒˤarˤ ‘neighbor’	wadˤʒˤarˤ	adˤʒˤarˤn	wadˤʒˤarˤn
	ilm ‘skin’	jilm	ilmawn	jilmawn
	udm ‘face’	udm/wudm	udmawn	udmawn
		- **Feminine Nouns**		
c-	tafruxt ‘girl’	tfruxt	tifrxin	tfrxin
	tifdnt ‘toe’	tfdnt	tifdnin	tfdnin
d-	tallunt ‘sieve’	tallunt	tallunin	tallunin
	tunfijjt ‘hiding’	tunfijjt	tunfijjin	tunfijjin

4.2. Constant vs. non constant initial vowels

We observe that the initial vowel may be either maintained in the CS or not. In early literature, the FS is assumed to be the base form of the CS (Applegate, 1958; Abdelmasih, 1971; Guerssel, 1983; Jebbour, 1991). However, our analysis relies on the assumption that a reference to the root structure is a mandatory process in the derivation of both the FS and the CS. In this study, we contend that the initial vowel of Tashlhit nouns that appeals to glide formation of the CS affix is part of the abstract form, the root (El Hamdi, 2018). An argument in support of this idea emerges from deverbal nons in which we observe the consistent presence of the initial vowel in question in both verbal and nominal morphology.

For a better understanding of our argument, it is important to be aware of the morphology of the CS in Tashlhit. We assume that the CS of Tashlhit nouns resorts to affixation in which the CS of a-initial nouns is characterized by an affixal *u-* in the masculine form and by the absence of the initial vowel in the feminine form. Consider the data below for the sake of clarification.

(72)

	Root	**Aorist**	**Imperfective**	**Perfective**	**N .FS**	**N. CS**
a-	√kʃm	kʃm ‘enter’	kʃʃm	kʃm	**a**kʃʃum	**u**kʃʃum
	√frg	frg ‘border’	ffrg	frg	**a**frig	**u**frig
b-	√nkr	nkr ‘wake up’	nkkr	nkr	t**a**nkra	tnkra
	√gn	gn ‘sleep’	ggan	gn	t**a**guni	tguni

The CS of Tashlhit nouns with consonant initial roots (56-a) surfaces with the CS affix *u-* and with no prefixal vowel in the feminine form (56-b). We will present further details on why the

prefixal vowel does not surface in the feminine form in a later section. For nouns with vowel initial root, consider the examples below in (73).

(73)

	Root	**Aorist**	**Imperfective**	**Perfective**	**N .FS**	**N. CS**
a-	√**a**ls	**a**ls ‘repeat’	tt**a**ls	**u**ls	**a**llas	w**a**llas
	√**a**ss	**a**ss ‘tie’	tt**a**ss	**u**ss	**a**ssas	w**a**ssas
b-	√**a**g^{w}l	**a**g^{w}l ‘hang’	tt**a**g^{w}l	**u**gl	t**a**guli	t**a**guli
	√**a**rw	**a**ru ‘give birth’	tt**a**ru	**u**ru	t**a**rwa/**a**rraw	t**a**rwa/w**a**rraw

Nouns with vowel initial roots surface in the CS with an initial glide *w* instead of an initial full vowel *u* in the masculine form (73-a) and maintain the vowel in question in the feminine form (73-b).

The consonantal root is unable to explain the presence/absence of the initial vowel in the CS of Tashlhit nouns. In addition, the constancy of the initial vowel in both verbal and nominal morphology cannot be accounted for using a consonantal base structure. This is a further argument for the inadequacy of the consonantal root hypothesis, suggesting that a reference to the vocalic root is of high relevance for the understanding of the variation between nouns that surface in the CS with an initial vowel and those that surface with an initial glide.

We support the claim that the initial glide *w*- expresses the CS in masculine forms to avoid the vowel hiatus that the affixal vowel *u*- would have created when put in adjacency with the radical initial vowel (*u*+*allas*→ *wallas*). When the noun has a consonant initial root, the CS affixal vowel remains as is, having no need to resort to glide formation (El Hamdi, 2018). The

distinction between root initial vowel and root initial consonant is clearly demonstrated in feminine Tashlhit nouns where only the radical vowel is maintained in the CS.

4.3. Optimality Theoretic account of the CS

Having looked briefly at the morphology of the CS of Tashlhit nouns, we will now argue that the presence/absence of the initial vowel in the CS of feminine forms and the glide/vowel alternation in the CS of masculine forms is an effect of interacting markedness and faithfulness constraints with a significant reference to the root. With this end in view, we present a constraint-based analysis to the morphology of the CS of Tashlhit nouns. Below are the constraints that are of relevance to our analysis.

(74)

MAX-Rt : input root segments should correspond to output root segments

DEP : output segments should correspond to input segments

***VV** : adjacency of vowels is prohibited

MAX-Aff : input affix segments should correspond to output affix segments

ALIGN-L (CS) : the left edge of the CS affix coincides with the left edge of the prosodic word

ALIGN-L (Fem): the left edge of the feminine affix coincides with the left edge of the prosodic word

IDENT [voc] : input and output segments have identical values for the feature [vocalic]

We now turn to the ranking of these constraints. In our analysis, we adopt the ranking MAX-Rt >> MAX-Aff (McCarthy and Prince, 1995) by dint of which the root constituents are more privileged than affix constituents. The CS of Tashlhit nouns support this ranking. In this case, the ranking primarily prevents the deletion of any root constituent. In addition, Tashlhit does not tolerate vowel sequences suggesting the relatively high ranking of the markedness constraint *VV to avoid the underlying hiatus caused by the adjacency of the CS affixal vowel and the radical vowel. Given this fact, Tashlhit nouns resort to glide formation as a repair strategy violating IDENT [voc]. Thus, the latter constraint is dominated. Glide formation leaves no room for epenthesis suggesting the high ranking of the faithfulness constraint DEP. Hence, we suggest the ranking exemplified in the tableaux below to account for the vowel/glide alternation in the masculine form (El Hamdi, 2018).

(75) Masculine nouns (v-initial roots)

CS, als	*VV	MAX-Rt	DEP	ALIGN-L	MAX-Aff	IDENT [voc]
i- als					*	
ii- u+ allas	*					
iii- u+ jallas			*			
iv- u+llas		*				
→ v- w+allas						*

The output wins over the competing candidates for it satisfies all the high ranking constraints. Its non-fatal violation of IDENT [voc] is due to the change of the vocalic feature of the CS affix. The high ranked constraints rule out candidates with no affix (75-i), candidates maintaining vowel hiatus (75-ii), candidates resorting to epenthesis to resolve the hiatus (75-iii) and candidates which delete the radical vowel as an alternative way to resolve the hiatus (75-iv).

The distinction between v-initial roots and c-initial roots is more clearly demonstrated in the CS of Tashlhit feminine nouns. Nouns with v-initial roots maintain the initial vowel in the CS whereas nouns with c-initial roots do not. Illustrative tableaux are presented below.

(76) Feminine nouns with v-initial roots

Fem, CS, ag^{w}l	*VV	MAX- RT	DEP	ALIGN-L (Fem)	ALIGN-L (CS)	MAX-Aff (Fem)	MAX-Aff (CS)
i- tuaguli	*				*		
ii- utaguli				*			
iii- tujaguli			*		*		
iv- uguli		*				*	
v- tuguli		*			*		
→ vi- taguli							*

(77) Feminine nouns with c-initial roots

Fem, CS, nkr	*VV	MAX- RT	DEP	ALIGN-L (Fem)	ALIGN-L (CS)	MAX-Aff (Fem)	MAX-Aff (CS)
i- tunkra					*		
ii- utnkra				*			
→ iii- tnkra							*
iv- unkra						*	

MAX-Rt preserves the radical vowel. Thus, the candidate surfacing with only the CS vowel and no radical vowel is ruled out. More intriguingly, the feminine form of Tashlhit nouns is marked by the absence of the morphological vowel (the CS affix *u*-). It is our contention that this is due to the 'non-availability' of the initial position in the prosodic word for it is occupied by the feminine affix (Lahrouchi, 2013; Bensoukas, 2010; El Hamdi, 2018). In OT terms, this is an effect of the interaction between ALIGN constraints and MAX constraints. As a result,

the CS prefix is not realized in feminine Tashlhit nouns to avoid 'misalignment' (Bensoukas, 2010). The author adds that plural nouns are also subject to the same generalization in which the CS affix is not realized leaving the room for the plural affix to surface. This is illustrated in the following tableau (78) (Bensoukas, 2010):

(78)

i+funas+n, CS	Realize-M(Pl.)	Align-L M-Pl	Align-L-M-CS
→a- ifunasn			
b- funasn	*!		
c- ufunasn	*!		
d- jufunasn			*!
e- wifunasn		*!	

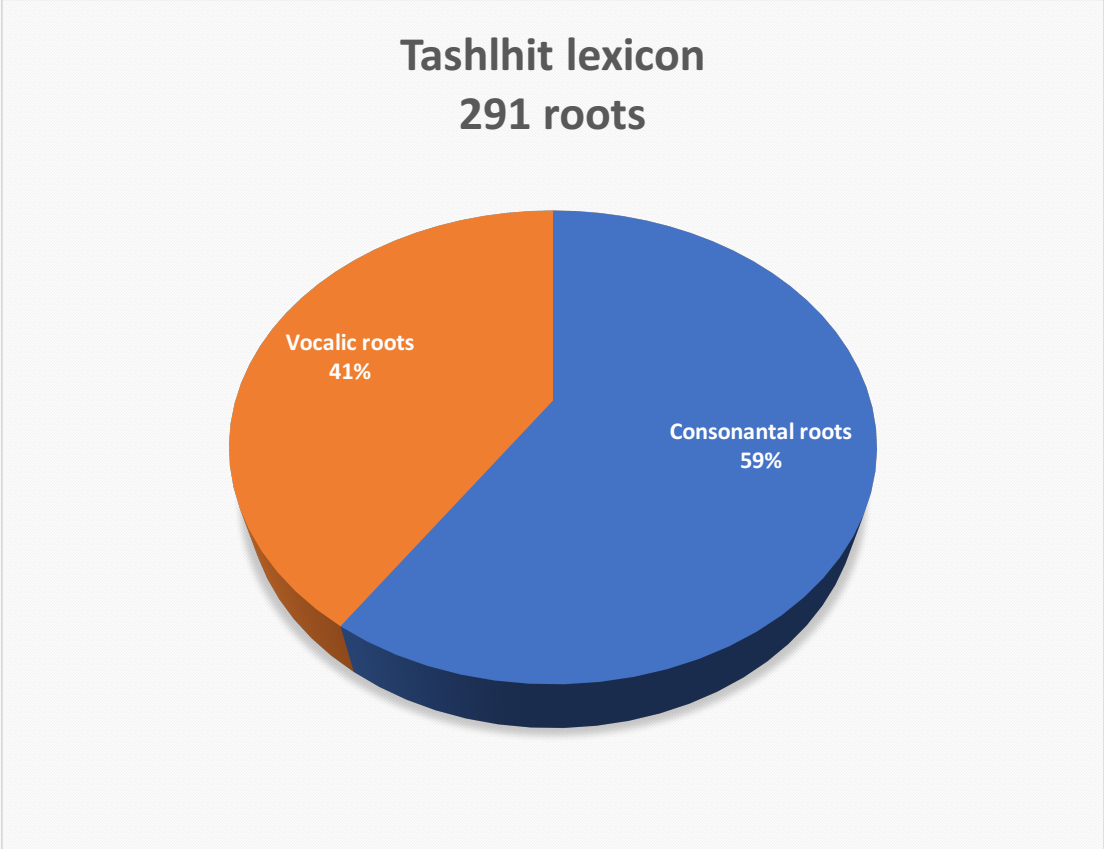
On the basis of the ranking established, no candidate will see its way to the surface except the one surfacing with only the plural marker. As is the case for feminine nouns, the plural form of Tashlhit nouns surfaces with the plural affix and not the CS affix. Both affixes compete over the initial position and the high interaction of ALIGN constraints and Realize-M(PL.) leaves the room for the candidate having just the plural marker and not the CS marker to win over the competing candidates.

In sum, we have proved so far that the root structure is a key element in the understanding of the regular and irregular patterns of the CS of Tashlhit nouns. Now that we have shown that roots contain vowels initially, medially and finally, we turn to a discussion of the theoretical implications of this view.

5. Theoretical implications

Under the full pursuit of the view that Tashlhit root structure consists of both consonantal roots and vocalic roots, we present a pie chart that represents the vocalic and consonantal roots of 291 triliteral and biliteral roots from which we derive verbal and nominal forms. We did not consider roots of nonderived nouns nor did we consider quadraliteral roots. However, we assume that what we have discussed so far about triliteral roots applies to quadraliteral and other roots as well. We only provide this representation for the sake of clarification of the main implication of the bipartite system for the Tashlhit lexicon.

(79)



We can now take stock of Tashlhit root structure. The relevant reference to the root has been shown to be of paramount importance in a number of languages (Arabic, Hebrew,

Amazigh). However, the juxtaposition of the root-based approach and the word-based approach cannot be overlooked. Although we have discussed the two approaches in the previous chapter, it is worth reiterating some of the relevant points here. A word-based approach has been advocated in various studies (Hebrew: Ussisshkin, 1999; Bat-El, 1994, 2003; Amazigh: Dell and Elmedlaoui, 1991; Moktadir, 1989; Arabic: Heath, 1997; Bensoukas, El Hamdi & Ziani, 2017) claiming that a word-to-word process is more harmonic than the root-based approach (Bat-El, 2003) and that the word-based approach satisfactorily accounts for a set of morphological cases. Both the word-based approach and the root-based approach are argued to be theoretically more relevant to the understanding of linguistic structures. A root-based approach implies a lexicon storage of a high number of abstract units at a general level although the Tashlhit lexicon has a less degree of root abstractness than other languages. We recall that a large number of roots in Tashlhit might be pronounceable units. A word-based approach, on the other hand, lends credence to a lexicon with less abstractness but to a high degree of redundancy (Ussishkin, 2006). Although our study presents significant grounds for the root in Tashlhit, it does not necessarily refute the role that a word-based approach might play in the language. Rose (2003), McCarthy (1979, 1981) and Arad (2003) appeal to considering both approaches in Ethiopian, Arabic and Hebrew, respectively. It would seem, therefore, that further investigations are needed to explore the necessity of considering the two approaches to better understand the linguistic system.

6. Conclusion

In this chapter, we argued that Tashlhit consists of roots as significant morphological units and we extended this point by providing further evidence that the Tashlhit lexicon is bipartite consisting of consonantal and vocalic roots. We examined the root structure thoroughly by investigating each position of a trisegmental root. We proved that the final, the

medial and or the initial position of roots in Tashlhit may be occupied by either a consonant or a vowel. Arguments emerge from the verbal and nominal morphology of Tashlhit.

We have reviewed previous treatments which dealt with the final position of Tashlhit root structure. We have accounted for the dropping of the final vowel in the aorist form of verbs having a final low vowel *a* in their root structure through constraint interaction. As driven by Realize Morpheme, the truncation process targets the final segment. However, with the high ranking of MAX-high vowel and the low ranking of MAX-low vowel, only low vowels are truncated in the final position. We also suggested that i-final verbs behave in a similar way to u-final verbs and that these verbs have vowel-final and consonant-final roots (glide-final roots) as a general characteristic of high vowel-final verbs in Tashlhit. We also proposed a unified constraint-based analysis to account for the perfective morphology of verbs having consonant-final roots, glide-final roots and high-vowel final roots.

We also distinguished between roots with medial vowels and roots with medial consonants. We introduced how the root has been considered with different conceptions in the Amazigh literature to account for the imperfective form. We also tried to explain that the consonantal root hypothesis cannot provide a satisfactory account to some verbal and nominal forms which surface with a constant medial vowel, suggesting that an appeal to vocalic roots is crucial.

We additionally demonstrated that the initial position of roots in Tashlhit may be occupied by vowels and consonants alike. We exemplified this claim through the construct state (CS) of Tashlhit nouns where we contend that masculine nouns form the CS through affixation and that feminine nouns lack the initial CS affix *u-*. The data reveals that the CS of masculine nouns shows a vowel/glide alternation of the CS affix *u/w* whereas the CS of feminine nouns shows an absence/presence of the initial vowel. We presented an analysis under

the premises of the same theoretical framework we have been adopting so far (OT) where we explained that it is an effect of constraint interaction where alignment constraints interact with the universal ranking MAX-Rt and MAX-Affix. The latter ranking preserves the root initial segment be it a vowel or a consonant whereas the alignment constraints explain the initial position of the CS affix and more intriguingly the absence of the CS affix in the feminine form.

We also presented a representative chart of a number of roots from which we derive verbal and nominal forms to demonstrate the main implication of the co-constituency of vocalic and consonantal roots in the Tashlhit lexicon. We also positioned our view within the theoretical discussion on word-based and root-based approaches.

We now turn to summarize the discussion up to this point. These facts turn out to be entirely compatible with the view that the Tashlhit lexicon consists of vocalic roots. We contend that there is no denying however of the coexistence of consonantal roots along with vocalic roots in the Tashlhit lexicon. This explains the pertaining of the hybrid grammatical system of Tashlhit where both concatenative and non-concatenative morphologies are at play.

CHAPTER IV

SUPRALIMINAL AND SUBLIMINAL PRIMING IN TASHLHIT

CHAPTER IV: SUPRALIMINAL AND SUBLIMINAL PRIMING IN TASHLHIT

1. Introduction

In the previous chapter, we discussed the morphological structure and the internal structure of the root, in particular, from a purely theoretical point of view. The main objective of this chapter is to examine the lexically represented structures in the language. Tashlhit remains an unexplored language in the psycholinguistic field. Our main goal is to study the morphological structure in the Tashlhit lexicon with an in-depth consideration of the root structure.

A considerable look at the corpus we collected in this study yields to a tentative conclusion that most items belonging to the same morphological family share meaning. A few morphologically related items do not. Examples are: *nkr* 'wake up', *tankra* 'action of waking up', *ssnkr* 'wake up sb'; *dl* 'cover', *amdlu* 'cloud', *isdal* 'cover, noun.'; *arm* 'try', *tirmt* 'food', *urm* 'tries'; *hddn* 'calm', *ahddun* 'burnous'. Hence, before we examine the role of the root and discuss the morphological effect, we will try in this chapter to examine the semantic effect in the Tashlhit lexicon. We will discuss the lexical representation of semantics and test whether semantically related items would facilitate the recognition of each other. Our main objective is to investigate to what extent can semantics facilitate lexical access before we proceed to examine whether the root facilitates lexical access. As is already mentioned, many items, that share the root, also share meaning. Hence, the point is to check out semantic effect to avoid semantic bias when examining the root effect. Furthermore, this study will contribute to semantic priming, bringing to the light results from a newly investigated language in terms of priming studies.

With this end in view, this chapter will be organized as follows. Section 2 will review the major works that have studied semantic priming effect in different languages. Section 3 will detail word frequency and semantic relatedness. In this section, we will explain how we proceeded in our corpus and data selection to avoid frequency issues; inasmuch as the use of more frequent and less frequent words haphazardly may highly bias the results. In the same section, we will detail the type of tests we used to select the semantically related items and the type of semantic relation we adopted in this experiment and in the subsequent ones. In section 4, we will briefly mention the pilot studies and the masked priming experiments that did not work out. Section 5 will be about our main contribution which is about the semantic priming experiment in Tashlhit with all the details on the method and the results. Then, we will conclude in section 6.

2. On Semantic Priming Effect

It might sound obvious that two words that are related semantically may facilitate the recognition of each other more quickly. Many studies endorse this claim, stating that a target word is recognized faster when it follows a semantically related prime than when it follows an unrelated prime. In the light of this, Neely (1976) and others argued that when a prime is processed, its semantic memory gets activated. However, semantic relatedness and its impact on the word recognition process remain a debatable issue. On the one hand, semantic relatedness is a controversial term referring to different types of semantic relations (Meyer, Schvaneveldt and Ruddy, 1975; McRae, De Sa, & Seidenberg, 1997; McRae and Boisvert, 1998; Moss, Ostrin, Tyler, and Marslen-Wilson, 1995) and, on the other hand, semantic priming effect has been a matter upon which there has been confusion and disagreement among a number of scholars (Becker, 1980; Blumstein, Milberg & Shrier, 1982; Slowiaczek, 1994; Deutsch, Frost and Forster, 1997).

Semantic priming has been affirmed in a number of studies regardless of the modality and the task used (Balota, 1983; Becker, 1976 cited in Becker, 1980; Slowiaczek, 1994). The semantic priming effect is due to shared features between prime and target (Deutsch, Frost and Forster, 1998). Milberg and Blumstein (1981) cited in Blumstein, Milberg & Shrier (1982) tested semantic priming effect using lexical decision task in the visual modality. The results showed that semantic priming obtains with both participants with 'Wernicke's aphasia' and participants with no aphasic issues. Participants recognized a real word target more rapidly when primed with a semantically related real word than when primed with a non-related real word or a nonword prime. In a later study, Blumstein, Milberg & Shrier (1982) argued against the use of the visual modality with aphasic patients and replicated the study of Milberg and Blumstein (1981) using the auditory modality. As a result, the study demonstrated that unlike in a semantic categorization task, in a lexical decision task, even patients of Wernicke's, Global, Broca's, and Conduction aphasias showed semantic facilitation effects. Similarly, Slowiaczek (1994) demonstrated that semantic priming is obtained whether the prime is auditorily or visually presented. This suggests that semantic priming is independent of the visual/auditory modality and rather proves that semantic properties are stored in the mental lexicon. The effect of semantics on word recognition has also been demonstrated using a different task 'single-word shadowing task', where the participant repeats (shadows) a target very quickly when preceded by a semantically related prime than when preceded by an unrelated prime.

Other studies on word recognition reached a contrasting conclusion about the effect of semantics on word recognition. In studies in which morphological effect has been tested using pairs sharing transparent or opaque semantic relation, morphological effects obtained even when the semantic relation is opaque, i.e., not necessarily sharing any semantic properties (visual lexical access: Boudelaa and Marslen-Wilson, 2005, 2013; auditory priming: Emmorey,

1989). In studies which tested pairs of words that are semantically related but not morphologically related, the outcome showed no priming effect, suggesting that semantics plays no role in lexical access facilitation (Deutsch, Frost and Forster, 1997). We will have more to say on the morphological and semantic effect in the following chapter.

In the present study, experiment 1 will contribute to this debate using new data from Tashlhit to test whether semantic priming obtains in the Tashlhit lexicon using a lexical decision task. The goal is to examine at which point the stored lexical representations become available to language processing, assuming that the main objective of lexical processing is to make the stored information of a given word available (Frauenfelder and Tyler, 1987). To our knowledge, no such experiments have been previously reported on Tashlhit language processing.

3. Semantic relatedness and word frequency

3.1. Frequency

As there is no established corpus from which to obtain frequency counts in Tashlhit, frequency of occurrence was estimated by 12 participants aged from 18 to 40 who did not participate in either of the priming experiments. The participants were requested to rate the auditorily presented list of words based on how frequently they encountered a word on a 7-point scale (1=never, 2= once a year, 3= once a month, 4= once a week, 5= once every two days, 6= once a day, 7= several times a day). Balota, Pilotti & Cortese (2001) proposed the latter scale arguing against the familiarity survey (Gernsbacher, 1984) where other variables (semantic, phonological and orthographic) may interfere in the participant's sense of familiarity. All the stimuli used in this experiment and in all the subsequent experiments are rated at least 3 by 90% or more of the subjects.

3.2. Semantic relatedness

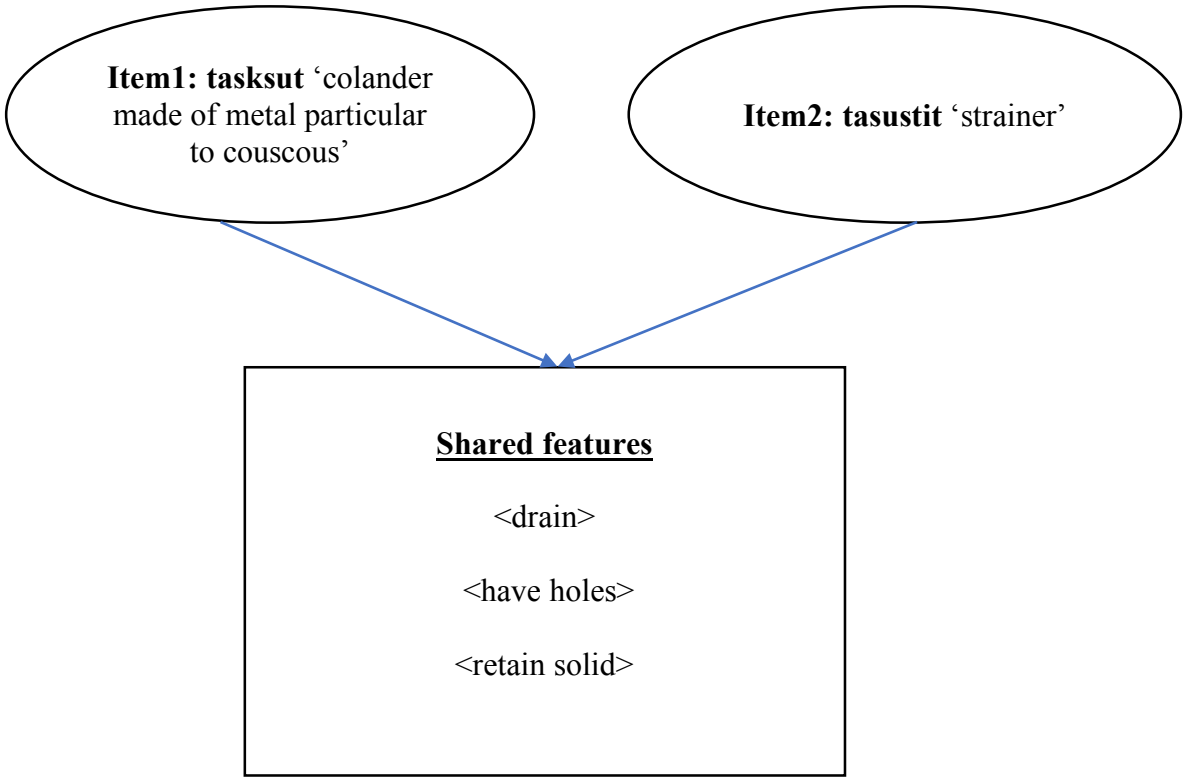
Various definitions of semantic relatedness between prime and targets are used in semantic priming literature. Pairs that are semantically related might refer to synonyms (Schluter, 2013), semantic associates (Meyer, Schvaneveldt and Ruddy, 1975) and or members of the same semantic category (Battig and Montague's,1969, cited in McNamara (2005)). McRae and Boisvert (1998) and Moss, Ostrin, Tyler, and Marslen-Wilson (1995) define semantic relatedness as any relation which might serve to define a given word. In the present study, we will define the semantically related pairs as the ones which share highly semantic features having a semantic feature overlap (McRae, De Sa, & Seidenberg, 1997; Bueno and Mestre, 2008).

Our choice of the semantic feature overlap as the type of semantic relatedness we are adopting in this study is based on two major arguments. First, it is based on the subsequent experiment where we test both morphological and semantic priming effects. A number of the target words are morphologically and semantically related because we lack a representative number of morphologically related but not semantically related items. These pairs share the morphological root and they are semantically similar but they are neither semantic associates nor synonyms. Rather, they share highly semantic features (e.g., for *taffarnut* 'traditional oven used to cook a particular bread called '*tannurt'* ': <cooking>, <for bread>, <traditional>). Thus, we are more entitled to test the effect of semantic feature overlap so that we can accurately assess both the morphological and semantic priming effect. Furthermore, Bueno and Mestre (2008) argue that the semantic feature overlap produced facilitation early, at short SOAs (Stimulus Onset Asynchronies), regardless of any associative link between the prime and target, whereas semantically associated pairs show no semantic priming effect at short SOAs. Thus, following this claim, using semantic associates as prime and target pairs might have a

misleading result on the semantic priming effect we obtain. McRae and Boisvert (1998) adds that failures to find semantic priming can be due to the use of weakly semantically related pairs. Hence, a sufficient amount of semantic relatedness is a crucial requirement in priming studies (Van den Bussche, Smets, Sasanguie & Reynvoet, 2012).

The task of selecting the experimental stimuli was divided to two parts:

Part 1. The first one was to produce the set of semantically similar items.[34] Two native speakers were requested to generate for a given word as many items as they can that share semantic features with the given word. They were allowed to use words that fall under the same semantic category (utensils, food, animals, clothes). Later, these items were assigned to another two participants to choose for each word the corresponding item with the high number of shared features.



[34] We use 'semantically similar' to refer to the pairs which share highly semantic features.

Part 2. The second part was to examine the selected pair of similar words. To this end, we designed a semantic pre-test to investigate to what extent these pairs are highly similar. A first attempt using a 7-point scale (Bueno and Mestre, 2008) confused the participants. Hence, we had to revise the scale to get more accurate responses. 10 participants were asked to rate the auditorily provided pairs on a 5-point scale, from 1 (not at all semantically similar) to 5 (highly semantically similar). Each participant was instructed to rate the given pairs based on their first impression with regard to their feature overlap. Examples were provided so as to avoid responses based on "associative relatedness".

4. Subliminal priming

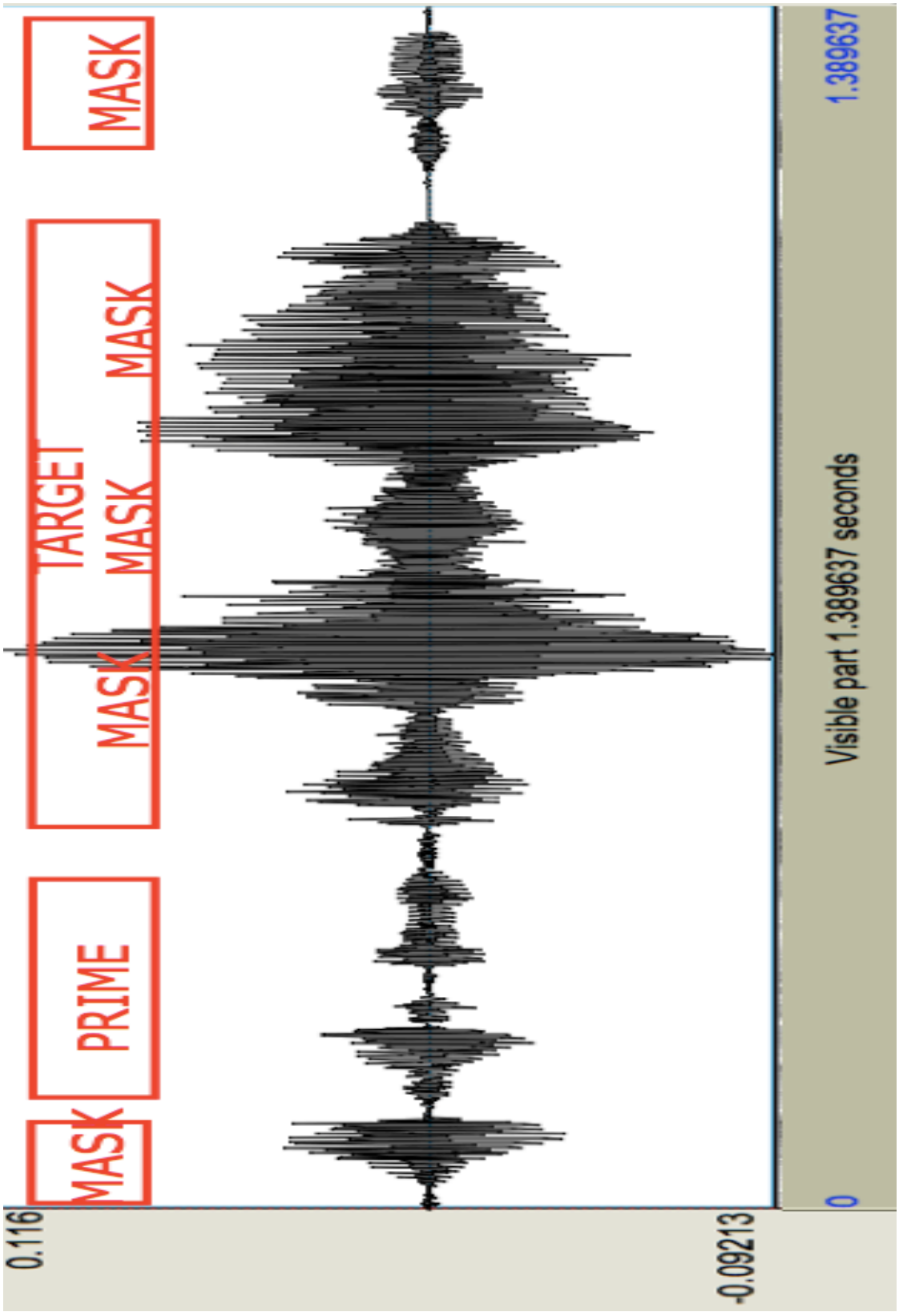
The objective of this experiment is to examine to what extent the semantic priming effect is automatic using masked or subliminal priming (Forster and Davis, 1984) in the auditory modality with new data from Tashlhit. In this experiment, we used a lexical decision task. In this speech subliminal priming technique, the auditory prime stimuli are compressed and uttered simultaneously with a noisy background speech for the participant to be unconsciously aware of the presence of a prime (Figure 4).

Speech subliminal priming examines the early stages of spoken word recognition. The prime may or may not be identified by the participant depending on the rate of time compression (Kouider and Dupoux, 2005). We conducted two pilot studies using different compression techniques to detect identity priming. We used Kouider and Dupoux's (2005) technique, which obtained identity priming with French-speaking participants at 35% and 40% compression rates. In this trial, the prime stimuli were compressed at 35% rate and compressed at fixed prime durations (240ms, 260ms and 280ms) following the technique used by Schluter (2013) with Moroccan Arabic data. The participants were asked by the end of the experiment if they had noticed the presence of any prime and none of them had reported a positive answer.

These priming techniques were tested in all the following experiments (a total of 8 experiments) and none of them yielded a repetition priming effect. Hence, we adopted the supraliminal priming technique in all the experiments that follow.

In our analyses of the data, we used the reaction times (RTs) from both target onset and target offset. We also removed the outliers. RTs that are greater than 2000ms were trimmed away and data points for which RTs from target offset are greater or less than 2.5 standard deviations away from the mean were also removed. We also tried log and reciprocal transformations of RTs. However, none of these pilot studies obtained any priming effect, not even in the identity condition in all the experiments. This suggests that a consideration of another technique was deemed necessary.

Figure 4: Masked stimuli at 35% time compression rate



5. Experiment 1. Supraliminal semantic priming

We designed experiment 1 using non masked technique (supraliminal) in which the participant is aware of the prime and auditory lexical decision task. Experiment 1 aims to determine the role of semantics proper in the Tashlhit lexicon in late stages of spoken word recognition. The awareness of the prime yielded to priming effect in the identity priming condition.

5.1. Method

5.1.1. Participants

71 subjects participated in experiment 1 (25 males and 46 females). Three recruiters were hired to conduct the experiment with their relatives, friends and neighbors. Participants were both literate and illiterate and all of them claimed that Tashlhit is their mother tongue. Some of them are monolingual, some others are bilingual speakers of Tashlhit and Arabic and a very few claimed that they speak French as a third language. However, all the participants mostly speak Tashlhit at home with their relatives and with their Amazigh friends. The age of participants ranged from 18 to 45 with the mean age 24.01 and the median age 21. No subject participated in more than one experiment. The results of participants who reported a hearing problem or had some language impairments were disregarded.

5.1.2. Materials

A total of 156 target words were presented to each participant in three priming conditions: identity or repetition, semantically related, and unrelated or control (Table 3). Primes and targets in the identity priming condition were exactly the same. Semantically related primes and targets shared 3 or more semantic features. The unrelated or control condition is where the prime and target were completely unrelated. The experimental stimuli

used in all the experiments were collected from dictionaries, data in articles and dissertations about Tashlhit and also from fieldwork data collection (Lasri,1991; Iazzi, 1991; Bensoukas, 2015; Lahrouchi, 2010; Boumalk, 2004; El Mountassir, 2003).

Table 3 : Experiment 1. Priming conditions with sample prime-target pairs.

Condition	**Prime**	**Target**
Identity/repetition	izikr 'rope'	izikr
Semantically related	ak^{w}rraf 'a long piece of cloth used to tie'	izikr
Unrelated/control	ssbaɣt 'paint'	izikr

12 target words primed with either a real word or a nonword were used as practice items to familiarize the participant with the task. The experimental stimuli were composed of lexically congruent and incongruent prime-target pairs. The former consisted of 36 real word targets primed with real words and of 36 nonword targets that were primed with nonwords, a total of 72 congruent pairs. Incongruent pairs, on the other hand, were not divided into different priming conditions. However, they also consisted of 72 targets, 36 of which were real words primed with nonwords and the remaining 36 targets were nonwords primed with real words. Incongruent pairs were used in this experiment as fillers so as to prevent the participant from developing a systematic way to guess whether the word is a real word or not based on the prime lexicality (Appendix E). Congruent pairs were subject to the different priming conditions whereas incongruent pairs were not; they were just pairs of unrelated words. For this experiment, we designed three lists counterbalanced by priming condition using a Latin square so that no target word was repeated in the same list and each target word is presented in each list with a different prime (Table 4). As a result, each participant heard each target only once. The counterbalancing was executed for congruent pairs only since they were the ones in which

one target word is related to three primes: an identical, a semantically related and an unrelated prime and hence had the chance to be heard three times.

Table 4: Real word target-primes in counterbalanced lists.

Target	**Prime List1**	**Prime List2**	**Prime List3**
izikr	izikr (**Identity**)	ssbaɣt (**Unrelated**)	ak^{w}rraf (**semantics**)
tannurt ‘a type of tortilla bread cooked in a special oven called *taffarnut*’	az^{ʕ}al^{ʕ}im ‘onion’ (**unrelated**)	tawnift ‘Berber bread cooked in an oven made of soil’ (**semantics**)	tannurt (**identity**)
lɦif ‘heat’	lɦma ‘warmth’ (**semantics**)	lɦif (**identity**)	agzzar ‘butcher’ (**unrelated**)

The use of nonwords in all the experiments was designed to check for repetition priming condition assuming that the participant would produce a faster response to nonword targets showing that repetition priming condition produces a priming effect regardless of the word lexicality (Ussishkin, Dawson, Wedel and Schluter, 2015). To create nonword stimuli, we generated a list of possible but unattested roots in Tashlhit which do not violate any structure constraints of the language. These included: OCP (Obligatory Contour Principle) with labials, coronals, velars and gutturals (Lahrouchi, 2009, 2018a), labial dissimilation /***m****sallam*/: [***n****sallam*] ‘greet’ (Boukous, 1987; Bensoukas, 1994, 2001, 2015), anteriority assimilation of sibilants /skʃm/: [ʃkʃm] ‘enter, causative’ (Lasri, 1991; Elmedlaoui, 1992; Bensoukas, 2004a) and voicing assimilation /ssugz/: [zzugz] 'take downstairs’ (Lasri, 1991, Elmedlaoui, 1995). Examples of nonwords are: *√nʃl → tanʃla, √ʃlb → taʃlba, aʃlab* .Then we associated these roots

with existing word patterns concatenatively and non concatenatively. All the created nonwords were vetted by two native speakers of Tashlhit to remove the stimuli which were judged to be similar to an offensive word or to resemble to a real word. All the experimental stimuli are in Appendix A.

All the stimuli were recorded by a female Tashlhit speaker who was from the same area as all the subjects who participated in the experiments. The native speaker recorded all the items using a head-mounted Audio-Technica ATR3350 Omnidirectional Condenser Lavalier Microphone and a TASCAM DR-40 digital recorder. The participant was asked to repeat each word three times and the token with the clearest articulation was selected. The selected token was demarcated, labelled and extracted as a sound.wav file using Praat text grids and a Praat script.[35] Real words and nonwords were recorded simultaneously to have more chances of recording all the stimuli in the same manner so as to avoid having a specific tone and or speed for real words or nonwords in particular. This was checked later by calculating the mean durations of real words and nonwords. The mean duration was 600 ms for real words and 591 ms for nonwords. The recorded individual stimuli were combined to create prime-target sound.wav file with an inter-stimulus interval of 150 ms using a Praat script.[36]

5.1.3. Procedure

The experiment was administered in a quiet place using a laptop computer running DMDX software (Forster and Forster, 2003). On each trial, participants heard a prime, a 150ms inter-stimulus interval of silence, and then the target. The participants were orally instructed to respond as rapidly and as accurately as possible whether or not the second word they heard is

[35] The version of the praat script about sound and label extractor was written by Scott Jackson and last modified on: 12/28/08

[36] The used script was designed by Scott Jackson and edited by Jonathan Geary. For the auditory masked priming tests we tried earlier, we retrieved the script from https://github.com/dbqpdb/auditoryMaskedPrimingStimGenerator

a Tashlhit real word. Responses were entered using a Logitech Gamepad F310. The participants answered yes by pressing the button on the right and no by pressing the button on the left and all of them were asked to wear Audio-Technica ATH-M40X headphones while running the experiment. A 3000 ms timeout was measured from target onset. Participants who did not respond within 3000 ms received a timeout visual feedback and were presented with the following pair of prime-target. They also got visual feedback for every response. As we expected both literate and illiterate participants to take part in the experiment, we designed a system of responses '√' / 'X' / '…' to substitute for the correct/incorrect/timeout visual responses, respectively. The participant started with 12 practice items before running the experimental stimuli. Half of the practice items consisted of real words and the other half consisted of nonwords. All of them were paired in the three conditions. The experiment lasted 10 to 13 minutes.

At the end of the experiment, participants were asked to answer a set of questions to control the sociolinguistic factors that may have an impact on the results. We opted for an oral questionnaire not to embarrass illiterate participants knowing that the task of the whole process of the experiment may have seemed strange. Answers to these questions were manually recorded. These questions were used as factors in the models we used in our analysis.

Figure 5: Questionnaire

Age:	How old are you?
Gender:	Male or female?
Mother tongue:	Which language is your mother tongue: Tashlhit/Arabic/Both?
Hearing:	Have you had any hearing problems?

Headphones:	Did you wear headphones during the experiment?
Home language:	Which language do you mostly use at home: Tashlhit/Arabic/Both?
Hand:	Are you left handed or right handed?
School:	Have you attended school? If yes, where did you go to ?

Questions about headphones, hearing, mother tongue, home language and hand were used to sort out which data to exclude. We excluded data from participants who did not wear headphones and the ones with hearing issues to exclude any possibility of not well hearing the word. Data from participants whose mother tongue is a language other than Tashlhit and the ones who mostly speak a language other than Tashlhit at home was excluded. This has been done to get data from participants who only speak the language fluently so that we avoid errors of not knowing the word by non Tashlhit speakers. We also needed participants who frequently use the experimental stimuli. Data from left handed participants were excluded because the gamepad button to respond to yes is on the right side. Hence left handed participants might be slow in responding to yes when they think it is the right answer.

5.2. Results

The results of 41 participants were excluded out of 71 because of their lower accuracy rate than 70%. Incorrect responses were also removed from the analysis. Reaction Times (RTs) were measured from both target onset (RT onset) and target offset (RT offset). We will report the results in which we used RT onset although the results report no difference between the uses of RT onset and RT offset. The means, standard deviations and error rates of RTs by priming condition and by lexicality are reported in Table 5 and boxplotted in Figure 6. We used a linear-mixed-effects regression model in our analysis using R: A Language and Environment

for Statistical Computing (R Core Team, 2016) and an lme4 package (Bates, Maechler, Bolker & Walker, 2015).

We used a random intercept model and since some subjects and some items might experience priming effects differently, we wanted to include random slopes for priming condition. We created a new model which includes random slopes to account for a within-subject variation "(1+Cond|Subject)" and another one that also includes a within-item variation "(1+Cond|Item)". Then, we compared each of the two models with the random intercept model using a likelihood ratio test (LRT). The use of random slopes did not significantly improve the fit of the model. Random slopes by-subject report a non significant result (χ^2 (5) = 9.98, p > 0.05) and the model including both random slopes by-item and by-subject also report a non significant result (χ^2 (10) = 11.06, p > 0.05). Hence, we kept the random intercepts model as the simplest one. The factors or fixed effects used in our model are age, gender, school and priming condition along with the random effects: Subject and Item. Target duration might also be included in the model.

We examined whether the residuals of our model meet the assumptions of linear mixed effects model to avoid type I or higher type II error. The distribution of the residuals was close to normal (Figure 7). This was confirmed by running a Shapiro-Wilk test of normality in R (For real words, W = 0.94668, p-value < 0.001 and for nonwords, W = 0.94748, p-value < 0.001). We also examined whether collinearity is absent among fixed effects and whether the residuals exhibit homogenous variance across fitted values and the results showed that our data was good enough to work with (Figure 8).

We ran Likelihood Ratio tests to check for priming effects. We found a significant effect of priming condition with only identity priming faster than the control condition for both real words (χ^2 (2)=88.57, p <0.001, lowering it by 208.78ms ±17.34) and nonwords (χ^2

(1)=44.94, p<0.001, lowering it by 149,3ms ±19.49). Another significant priming effect for real words was found in the semantically related condition (χ^2 (1)=37.26, p<0.001, lowering it by 117.5ms ±17.36).[37]

Table 5: Experiment 1. Mean, standard deviation and error rates of Reaction Times (RTs) by lexicality and priming condition

Condition	Mean (ms)	Standard deviation	Error (%)
Real words			
Identity	503.09	248.66	45
Semantically related	593.95	251.5	44
Unrelated	712.95	293.46	42
Nonwords			
Identity	634.56	271.94	39
Semantically related	795.14	331.82	35
Unrelated	792.26	301.27	36

[37] Semantically related nonwords are just words that are unrelated but we used them as such for maintaining balance with the real words.

Figure 6: Experiment 1: Mean reaction times by priming conditions (Id: Identity, Rel: semantically related, Un: Unrelated) and lexicality with RR for real words and NN for nonwords

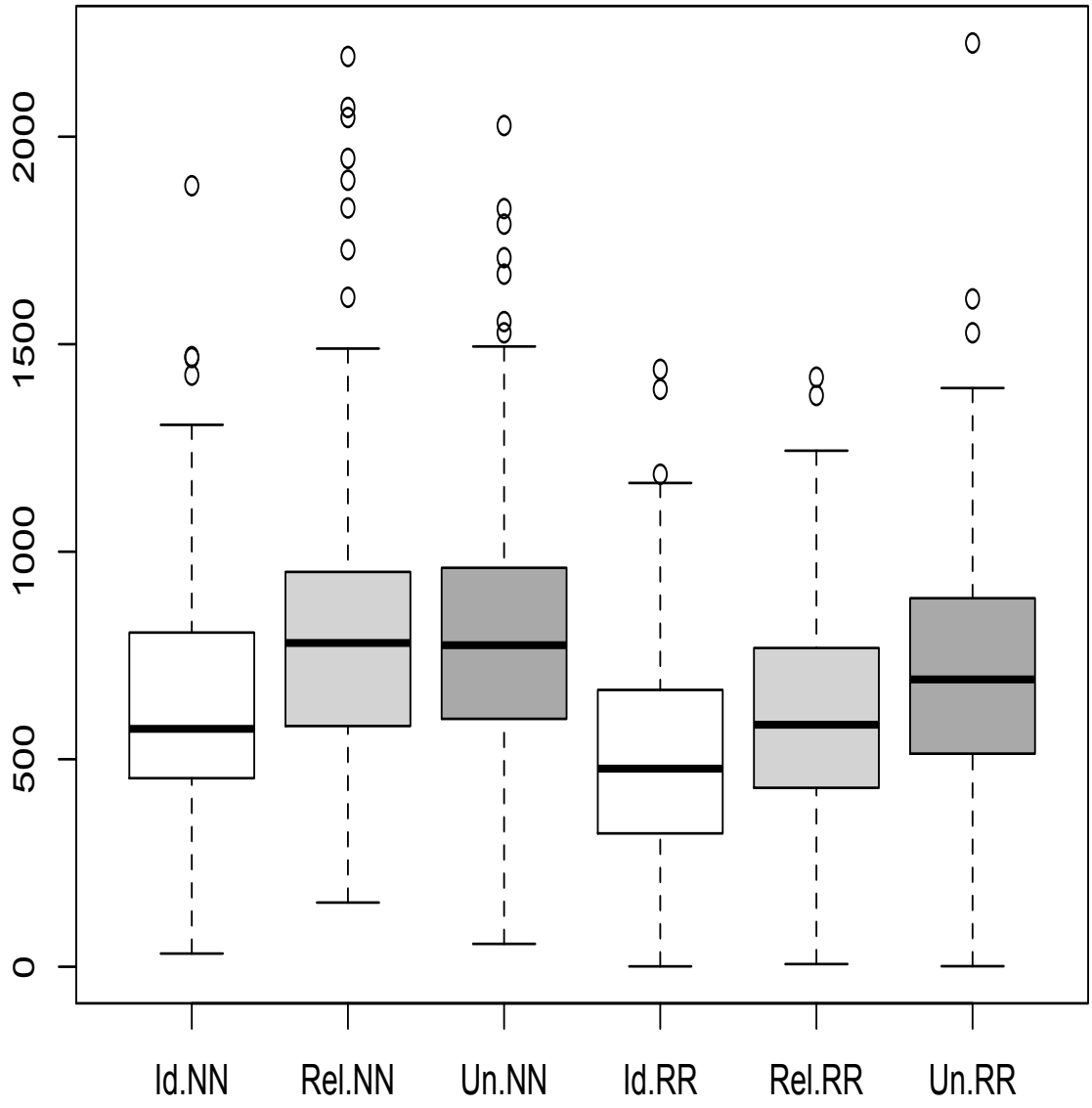


Figure 7: Experiment 1: Distribution of residuals with m1RR for real words and m1NN for nonwords.

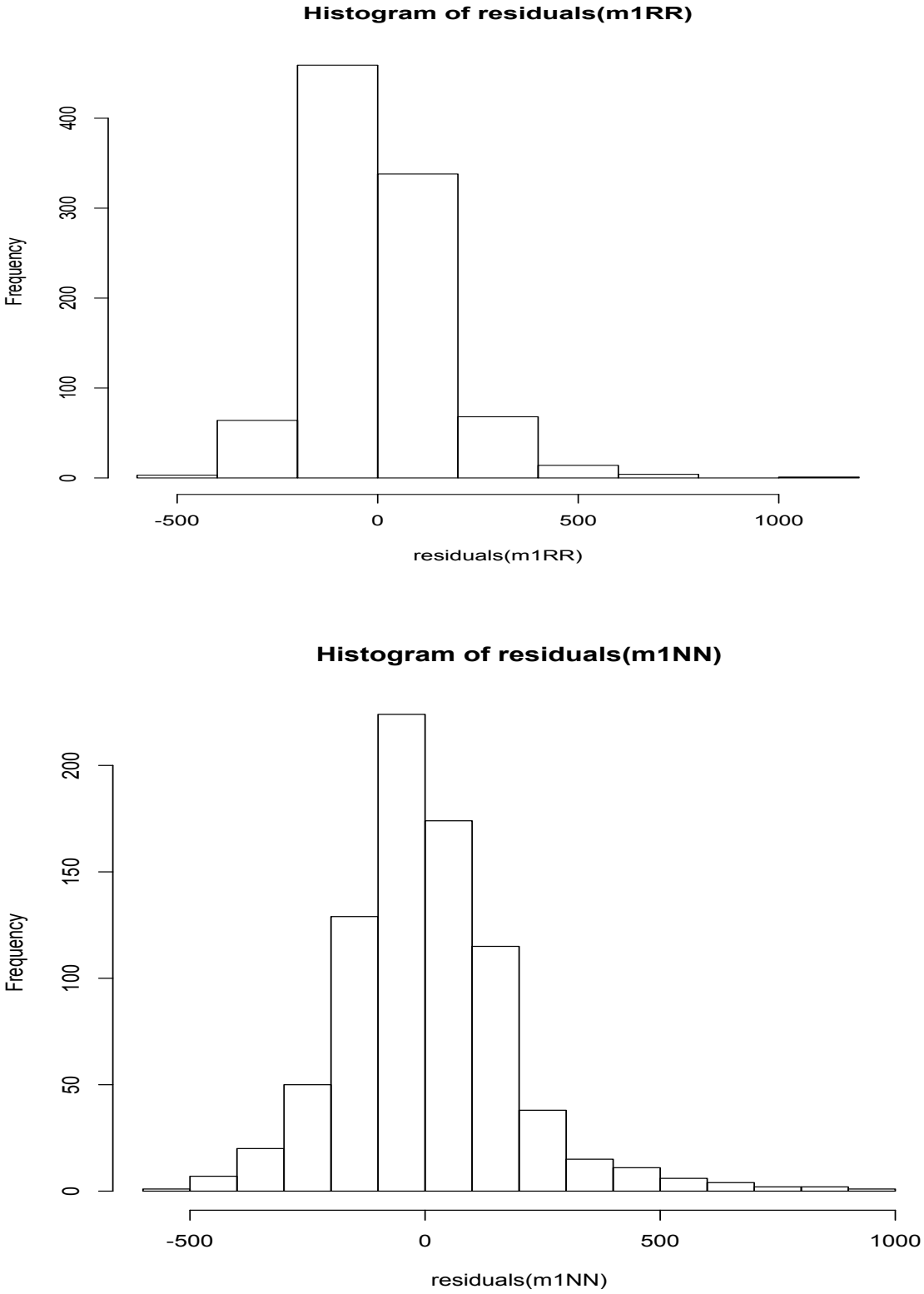
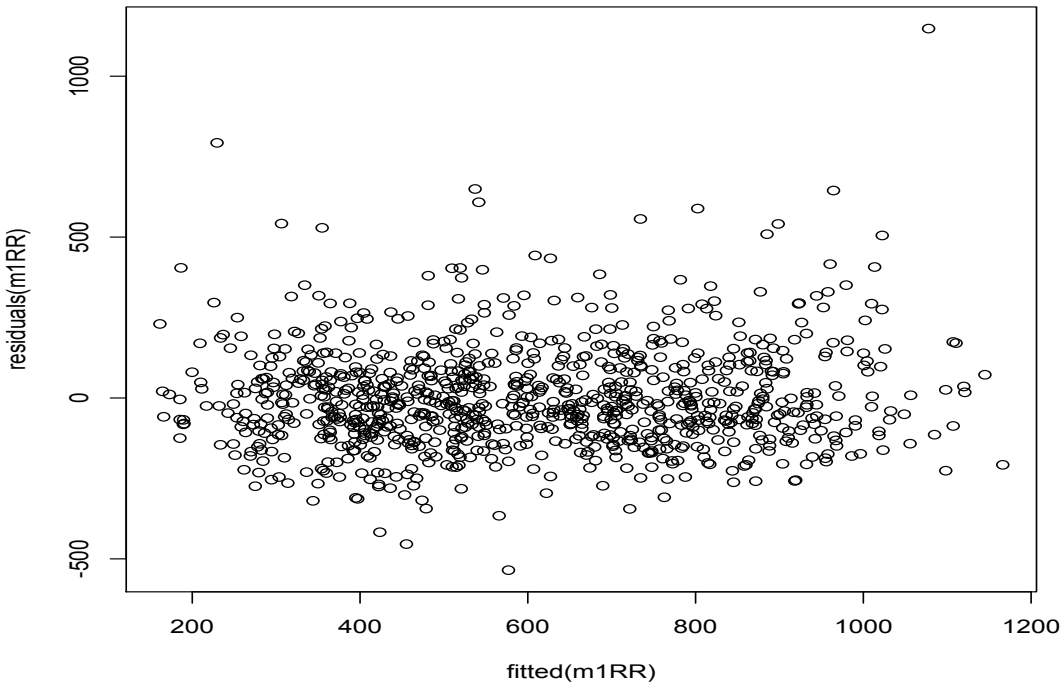
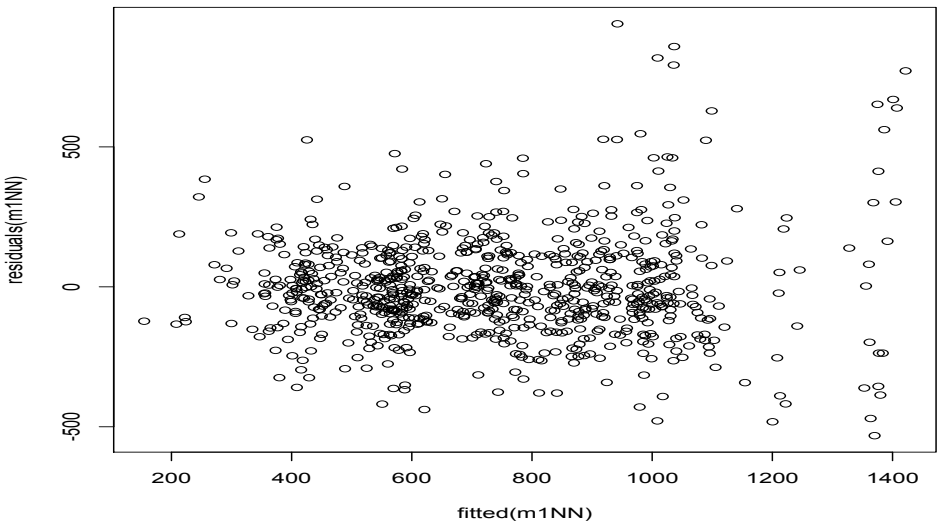


Figure 8: Experiment 1: Plots of residuals for real words (m1RR) and nonwords (m1NN)





5.3. Discussion

The results showed that semantics has a facilitatory effect in lexical access in Tashlhit. As we chose pairs that have semantic feature overlap as the semantically related items, a faster response to the target when primed by a semantically related word suggests that the prime and target share features that have some psycholinguistic reality. A facilitatory effect of semantic priming in the auditory modality has already been attested in other languages like English (Emmorey, 1989; Holcomb and Neville, 1990; Blumstein, Milberg & Shrier, 1982; Slowiaczek, 1994).

In other studies which tested semantic along with morphological effect, results showed an inhibotiry effect of semantic priming. In Semitic languages, particularly in Moroccan Arabic (Schluter, 2013), Hebrew (Deutsch, Frost and Forster, 1997) and Maltese (Ussishkin, Dawson, Wedel and Schluter, 2015), root priming showed a facilitatory priming effect whereas semantics showed no priming effect. We will discuss the morphology/semantic priming effect in experiment 2 in which we will test both morphology and semantics. However, it is important to note that the above mentioned studies adopted different methods in defining semantic relatedness between prime and target pairs.

The results of this experiment yield to two main conclusions. First, the presence of semantic priming effect in Tashlhit supports the methodology adopted in this study in defining semantic relatedness. Hence, this experiment contributes to arguing for the effectiveness of semantic feature overlap in the study of semantic priming. Second, the results of this experiment tap into the accessibility to the level of conceptual representations in the Tashlhit lexicon. This suggests that semantic shared portion in the lexical access process is active in the mental lexicon of Tashlhit native speakers. However, some sort of masked priming test would

be of high relevance to examine whether semantic priming effect would be obtained in early stages of word recognition process or limited to late stages of language processing.

6. Conclusion

In this chapter, we introduced the first priming study that has been done on Tashlhit. We introduced the two pretests we conducted before designing the experiment, the frequency and the semantic survey. The point was to select the experimental stimuli based on their equal frequency rate to avoid any extra factors that might influence the results we obtain. The semantic survey was designed to select the experimental items that are semantically related based on the native speakers' judgments. We did not assume any type of semantic relatedness but rather selected items that share highly semantic features.

We also used a set of techniques attested in early literature about subliminal or masked priming but none of them reached a facilitatory effect in the repetition condition, making it impossible to check for semantic priming effect. We then tried supraliminal or nonmasked technique with an audible and conscious awareness of the prime. Both repetition priming and semantic priming effect were obtained in this experiment and both effects were indistinguishable, suggesting the lexical representations of semantic features in the Tashlhit lexicon.

CHAPTER V

MORPHOLOGICAL EFFECT IN AUDITORY WORD RECOGNITION IN TASHLHIT

CHAPTER V: MORPHOLOGICAL EFFECT IN AUDITORY WORD RECOGNITION IN TASHLHIT

1. Introduction

The aim of this chapter is to discuss the notion of the root from a psycholinguistic perspective using priming studies. In previous chapters, we presented ample evidence for the significant role played by roots in understanding the morphological structures in Tashlhit. Further external evidence would be of high relevance to endorse the morphological theory we argue for in the present study. Three main approaches to morphological theory appeal to further external evidence: the decomposition theory, the word-based theory and the hybrid approach in which the two theories come to play in understanding the morphology of a language.

The decomposition theory is basically the decomposition of a visual and or auditory word into abstract morphemic entities represented in the mental lexicon. Falling under this theory, the lexicon is assumed to be organized into morphemic units that are linked to derived words sharing the same morpheme. Contrastively, under the word-based approach, the lexicon is organized into fully-specified words. One of the arguments against the word-based theory is that it causes redundancy through the existence of separate forms that are morphologically related as is the case for *cover*, *uncover*, *covering* (Wurm, 1997). In studies of language processing and word recognition, in particular, the decomposition theory reveals to be significant in lexical access using the visual modality (Boudelaa and Marslen-Wilson, 2005, 2013; Frost, Kugler, Deutsch & Forster, 2005) and the auditory modality (Emmorey, 1989; Boudelaa and Marslen-Wilson, 2013; Schluter, 2013; Gwilliams and Marantz, 2015). Other studies used cross-modal priming to test how efficient the decomposition theory is by exposing the subject to a visual prime and being asked to do a lexical decision task on an auditory target (Kielar & Joanisse, 2011).

Under the decomposition theory, the strong effect played by roots in word recognition process has been demonstrated in Semitic languages and Indo-European languages. A number of priming studies revealed the facilitatory role played by root morphemes in lexical access in early and or late word recognition process in Arabic (Boudelaa and Marslen-Wilson, 2001, 2005, 2013; Schluter, 2013; Gwilliams and Marantz, 2015; Al Kaabi, 2015), Hebrew (Deutsch, Frost & Forster (1997), English (Emmorey, 1989; Bentin and Feldman,1990; Rastle, Davis, Marslen-Wilson and Tyler, 2000), German (Smolka, Komlosi and Rösler, 2009) and French (Longtin, Segui and Hallé, 2003; Longtin and Meunier, 2005). A complete theory on word recognition process requires a view on how the mental lexicon is accessed in all and different languages. Hence, cross linguistic research is deemed necessary. To the best of our knowledge, Tashlhit is a Hamitic-Semitic language that has never been experimented using priming tests. Therefore, we aim, in this study, to test whether morphology in general and roots in particular facilitate the word recognition process by Tashlhit native speakers.

We will organize this chapter into five more sections. Section 2 will present the details of experiment 2 which will be about the morphological and semantic effect. In this section, we will try to reexamine the semantic effect along with the root effect in lexical access. We will try to investigate whether it is semantics or morphology that is activated in the brain while processing the language. Section 3 will discuss the phonological effect in the language. We will verify whether phonological factors facilitate lexical access. We will use three different phonological overlaps for that matter and we will examine whether it is the root effect or the phonological effect that facilitates lexical access. In section 4, we will focus on the morphological effect per sa. We will focus more on the effect of the structure of the root in language processing. We will investigate the effect of consonantal and vocalic roots separately to examine if both types of roots are lexically represented the same way.

2. Experiment 2: Form and Meaning in the Tashlhit Mental Lexicon

The significant effect of the semantic overlap in Tashlhit is not observed in Hebrew studies in which semantic overlap is not as efficient as the morphological overlap. Deutsch, Frost and Forster (1997) observed no priming when the words shared meaning but no root and that words sharing the root primed each other. The study tested semantic associates showing that semantic relatedness did not facilitate lexical access. Although the authors did not deny that semantic priming might be noticed at different conditions, they contend that lexical access and target naming can only be facilitated when a morphological relation pertains between the prime and target. Hence, root priming obtained irrespective of semantic overlap in Hebrew suggesting that roots in Hebrew are lexical units independent of meaning. The results were confirmed using two different tasks: lexical decision and naming tasks. One account for this is that in Hebrew, morphological decomposition theory is mandatory for the speaker or reader to process the word recognition. If a root derivation is presented, the root is extracted as a default process by the native speaker and allows faster recognition of any other derivation of the same root regardless of any semantic relatedness. We contend that the different results with regard to semantic overlap might be due to the semantic relatedness itself or to the priming technique. In the present experiment, we used semantically shared features and not semantic associates and tested them at late stages of word recognition process.

A semantic priming effect was found in experiment 1. In experiment 2, we will try to investigate the interaction between morphology and semantics in the mental lexicon of Tashlhit. We will try to determine whether the root in Tashlhit has a lexical role and whether its facilitatory effect, if any, depends on semantic relatedness. An examination of semantic and morphology interface is necessary to determine what activates lexical access. Previous studies reported a facilitatory priming effect when the prime and target share morphology but not

semantics (visual lexical access: Boudelaa and Marslen-Wilson, 2005; auditory priming: Emmorey, 1989). Others reported that morphological effect is dependent on semantic relatedness (Gonnerman, Seideberg & Andersen, 2007; Kielar and Joanise, 2011). In this experiment, we will use a lexical decision task in a supraliminal speech priming test in which the participant will be aware of the prime. We will examine whether it is the lexical representation of morphology or that of semantics that becomes available to language processing in late stages of spoken word recognition in Tashlhit.

2.1. Method

2.1.1. Participants

56 subjects participated in experiment 2 (22 males and 34 females). The age of the participants ranged from 18 to 42 with the mean age 26 and the median age 24. Two participants were removed for hearing problems and 24 were removed for their accuracy rate lower than 75; only data points from 30 participants were considered in the analysis. We also trimmed away incorrect responses from the analysis.

2.1.2. Materials

Each participant heard a total of 156 target words with both real words and nonwords which were paired in four priming conditions: identity, morphology and semantics (+root +sem), morphology but not semantics (+root -sem), semantics but not morphology (-root +sem) and the unrelated condition. Based on frequency and semantic surveys demonstrated in experiment 1, 16 target words were tested under the *+root -sem* condition and 20 target words were tested under the *+root +sem* condition (Table 6). 36 target words were tested in each of the other conditions. A total of 36 real word targets were primed with real words and a total of 36 nonword targets were primed with nonwords. Each participant heard 36 real words, which

were primed with nonwords, and 36 nonword fillers, which were primed with real words. Targets and primes were all nominal categories except for items in the morphologically related condition *+root +sem* and *+root -sem*, which were verbal forms (Appendix B). Except for the stimuli we used as fillers, the experimental stimuli were presented to the participant in four counterbalanced lists to make the target heard only once for each participant (see chapter IV for an example of counterbalanced lists). We used this technique in all the subsequent experiments.

Table 6: Experiment 2. Priming conditions with sample prime-target pairs.

	Identity	-root +sem	Unrelated	+root +sem	+root -sem
Prime1	ʃʃˤrˤitˤ 'a long piece of cloth used to tie'	izikr 'rope'	afras 'radish herb'		ʃˤrˤtˤ 'require'
Target1	ʃʃˤrˤitˤ	ʃʃˤrˤitˤ	ʃʃˤrˤitˤ		ʃʃˤrˤitˤ
Prime2	taʃˤttˤabˤt 'broom'	ifsski 'besom'	amzdaɣ 'cemetery'	ʃˤttˤbˤ 'sweep'	
Target2	taʃˤttˤabˤt	taʃˤttˤabˤt	taʃˤttˤabˤt	taʃˤttˤabˤt	

2.1.3. Procedure

The procedure in Experiment 2 was identical to that in Experiment 1.

2.2. Results

We report the results using the reaction times (RTs) measured from target onset (RT onset). We also analyzed RTs from target offset and the results were identical to those we got from RT onset. We constructed the models the same way as in experiment 1. The use of random

slopes did not significantly improve the fit of the model. Random slopes by-subject reported a non significant result (χ^2 (14) = 0, p = 1) and the model including random slopes by-item failed to converge.

We checked whether the random intercepts model met the linear mixed effects assumptions. The distribution of the residuals was close to normal (Figure 9). A Shapiro-Wilk test of normality confirmed the results (W = 0.90008, p-value < 0.001). Only the effects of Age and school were correlated but this does not affect the results obtained. Our interest was on the priming conditions and none of them were correlated satisfying the assumption of collinearity. We also checked whether our model met the assumption of homoscedasticity and found that the residuals showed more or less a similar amount of deviation from the predicted values (Figure 10). Hence, our model is showed to meet all the assumptions of linear mixed effects.

Priming occurred in the identity condition (χ^2 (1)=45.94, p<0.001, lowering it by 218.25ms ±29.71), in the condition in which the prime and target were morphologically but not semantically related (χ^2 (1)=10.76, p<0.01, lowering it by 124.97 ms ±37.43), in the condition where both morphology and semantics are shared (χ^2 (1)=28.42, p<0.001, lowering it by 196.10ms ±34.99) and in the semantics condition (χ^2 (1)=13.19, p<0.001, lowering it by 110.16ms ±29.67). There is also a significant priming effect for the identity condition with nonword trials (χ^2 (1)=26,53, p<0.001, lowering it by 164.5ms ±30.29). The means, standard deviations and error rates of RTs by priming condition are reported in Table 7 and graphically represented in Figure 11.

Table 7: Experiment 2. Mean, standard deviation and error rates of Reaction Times (RTs) by priming condition

Condition	Mean (ms)	Standard deviation	Error (%)
Real words			
Identity	741.86	300.41	18.84
+root+sem	764	285.53	24.04
+root-sem	834.83	305.56	28.49
-root+sem	844.21	330.44	20.68
Unrelated	965.46	296.45	19.46

Figure 9:Experiment 2. Distribution of the residuals for real *words.*

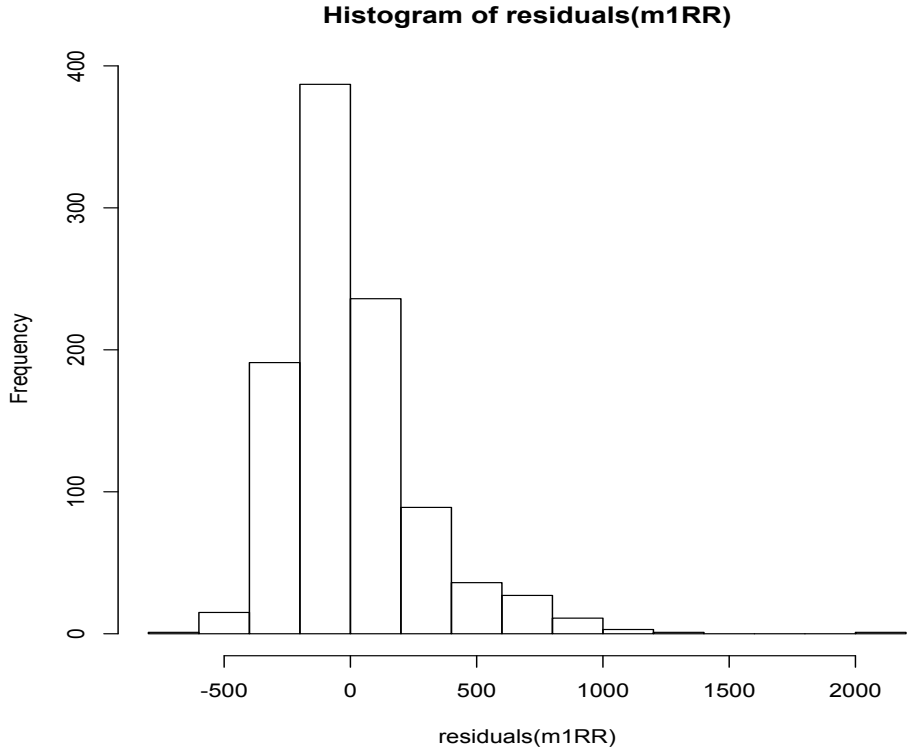


Figure 10: Experiment 2. Plot of the residuals for real words

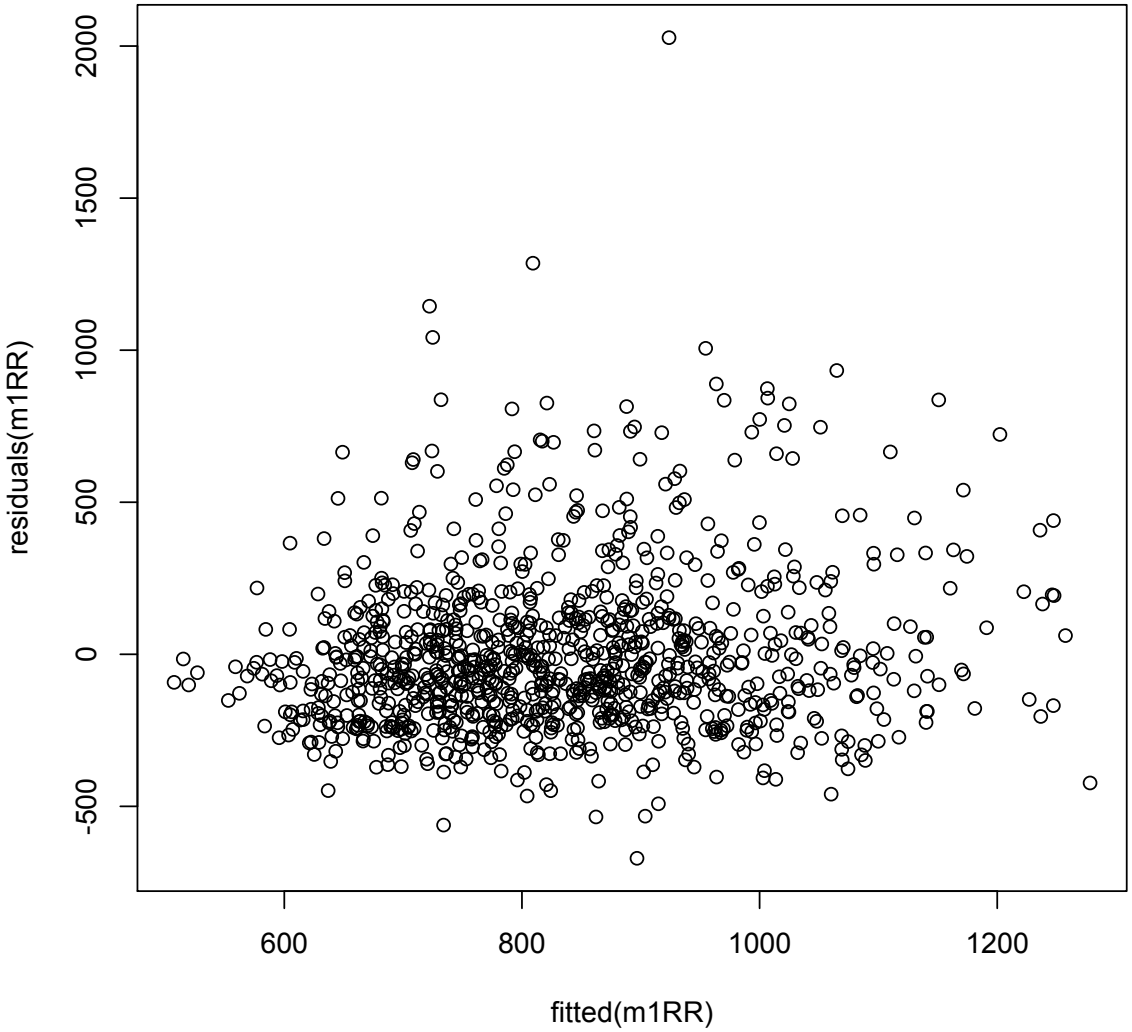


Figure 11: Experiment 2. Mean reaction times of real words by priming conditions

2.3. Discussion

The results of this experiment point to a facilitatory effect when the words share semantic features confirming the results obtained in experiment 1. To account for the strictly-morphological relation, one should control for other linguistic factors that may interfere with morphological word processing. Hence, to meet this requirement, we used pairs that shared the root with an opaque semantic relation. The results showed that a facilitatory priming effect occurred when the words shared the root regardless of semantic relatedness suggesting that morphology alone can produce priming.

This is consistent with the results obtained in Semitic languages. In Arabic, root priming effect was robust despite the fact that the semantic relation holding between the words is opaque (Boudelaa and Marslen-Wilson, 2001, 2005, 2013, 2015; Schluter, 2013; Gwilliams and Marantz, 2015; Al Kaabi, 2015). In the same vein, Hebrew studies also showed that root priming obtains regardless of semantic relatedness (Deustch, Frost and Forster, 1997, 1998, 2000).

In addition, Tashlhit words sharing semantic features but no root also primed each other. In order to know whether there is a significant difference between the semantic overlap effect and the morphological priming effect, we ran a Likelihood Ratio Test to compare the effect of words that are morphologically related but semantically opaque and words that are morphologically related and semantically transparent. We would predict that if semantic overlap has a significant effect, the morphological effect would be significantly reduced if there is no semantic transparency between the words. The results showed that the effect of words sharing the root and a transparent semantic relation and that of words sharing the root and an opaque semantic relation are not significantly different ($\chi 2$ (1)= 2.92, $p>0.05$). Hence, the morphological effect is robust regardless of semantic transparency. This is in keeping with the results obtained using incremental masked priming and lexical decision in Arabic visual word recognition (Boudelaa and Marslen-Wilson, 2005). The study investigated the functionality of morphemes over distinct time points. The results showed that root priming obtained regardless of orthographic and or semantic relatedness. Unlike semantic and orthographic effects, root effects occurred at the four investigated SOAs. Semantic effect, on the other hand, only occurred at late SOA (80ms). Moreover, the results showed that root priming had an equal strong effect with the words having transparent semantic relation and the words having an opaque one.

In this experiment, the results showed that the effect of words sharing the root with an opaque semantic relation (*aħddun-ħddn* 'burnous-calm') and that of words sharing semantic features with no root overlap (*taf^{ʕ}tt^{ʕ}abt-ifsski* 'broom-besom') are indistinguishable. Therefore, morphological effect is as strong as the semantic effect in Tashlhit suggesting that both morphological structures and semantic features are lexically represented in the Tashlhit lexicon. The robust effect of the root obtained in this experiment confirms the results obtained in a number of Semitic studies. In Arabic, priming tests showed that the root has a facilitatory

effect whether the words share a transparent or opaque semantic relation (Boudelaa and Marslen-Wilson, 2001, 2005, 2013, 2015; Schluter, 2013; Gwilliams and Marantz, 2015; Al Kaabi, 2015). Similar results were found in Hebrew in which native speakers recognize the root as a morphological unit independent of any semantic overlap (Deutsch, Frost and Forster, 1997, 1998, 2000).

3. Experiment 3. Supraliminal Phonological Priming Effect in Tashlhit

The results of the previous experiment showed a robust priming effect of the root arguing for the important role that morphology plays in word recognition. However, morphologically related words might also be phonologically related. The pairs *car-cars* and *friend-friendly* share both morphology and phonology and pairs like *car-card* and *tin-tinsel* share phonology but no morphology. Hence, different studies tend to investigate phonological and semantic factors independently of morphological factors.

In Hebrew studies, evidence has been presented for the facilitatory effect of the root independently of letters overlap. Letters which were not root letters did not facilitate lexical access nor target naming (Deutsch, Frost & Forster, 1997). This has been confirmed by Deutsch, Forster, Frost and Kugler (2005), which investigated to what extent form and or orthography can facilitate lexical access. The results showed that a facilitatory priming effect was observed when the prime and target shared the root but not necessarily a sequence of letters and that visual word processing is constrained by morphology and not by phonology.

Arabic priming studies also showed that morphology plays an important role in lexical access with emphasis on the non significant role played by phonology. Words sharing two to three consonants with no morphological and no semantic overlap (eg., *samiidun* 'semolina'-

ʃamsun ‘sun’) did not prime each other suggesting that phonological overlap does not facilitate lexical access in Arabic (Boudelaa and Marslen-Wilson, 2001, 2004, 2013, 2015).

Using different modalities in English, the results did not support the facilitatory effect of phonological structure. Using the auditory modality, the reaction times of words with more ‘neighbors’ were long; that is, more words that share phonological overlap were longer than words with fewer neighbors (Cluff and Luce, 1990). On the other hand, Yates, Locker and Simpson (2004) found evidence for phonological neighborhood in English using visual tasks. As a replication of the latter study, Grainger, Muneaux, Farioli and Ziegler (2005) found different results showing that the more orthographic features are shared between the words, the more chance phonological neighborhood density has in facilitating lexical access. In the same study, the authors also used a word identification task, and the results showed that phonology inhibits lexical access regardless of the number of orthographic neighbors. We contend that the results of the priming effects of the lexical decision task shown in Grainger, Muneaux, Farioli & Ziegler (2005) are due to orthography and not to phonology proper and hence phonology as tested in these studies has an inhibitory effect in word recognition.

Similarly in French, Radeau, Morais and Dewier (1989) examined phonological priming effect using lexical decision and shadowing tasks in spoken word recognition. The results showed that no priming effects were observed in neither of the tested phonological cases: sharing the first syllable= /*paɣyɣ*/, i.e., *PARURE* ‘ornament’ and /*pale*/, i.e., *PALAIS* ‘castle’, sharing the first phoneme= /*pale*/, i.e., *PALAIS* and /*pule*/, i.e., *POULET* ‘chicken’ or changing the first phoneme= /*ɣule*/, i.e., *ROULER* ‘roll’ and /*pule*/, i.e., *POULET*. Phonological priming was also tested at different compression rates (35%, 40%, 50% and 70%) in the same language and the results were similar, showing no phonological priming effect

(Kouider and Dupoux, 2005). The results obtained in these studies suggest that phonological activation affects word processing in neither Semitic nor Indo-European languages.

However, the absence of phonological priming is not confirmed by all priming studies. Phonological priming remains a debatable issue. The different interpretations of the effect of phonological priming might be due to the different priming techniques used in the experiments. This is illustrated in Moroccan Arabic where both phonology and morphology effects were found using supraliminal priming, but no phonology effects obtained using subliminal priming. In supraliminal priming experiment, morphology effects were 'indistinguishable' from identity effects suggesting that morphology is more robust than phonology and that phonology activation facilitates lexical access in late stages of word recognition in Moroccan Arabic, but not at early stages (Schluter, 2013). On the other hand, Halderman, Ashby and Perfetti (2012) presented a review with a set of evidence that argues for the important role that phonology plays in early stages of word recognition process. Arguments have been presented from experimental studies on visual word recognition using different tasks such as Eye movement and MEG studies.

In this experiment, we will try to confirm whether the effect obtained is due to the shared morpheme or just to the cluster of phonemes shared between the two words. We will try to test whether phonological factors yield a facilitatory priming effect. A further examination of whether the facilitatory effect of the root obtained in experiment 2 is purely morphological or phonological is the main objective of experiment 3.

3.1. Method

3.1.1. Participants

74 subjects participated in Experiment 2 (42 females and 32 males). The age of participants ranged from 18 to 45 with the mean age 26.71 and the median age 25. Data from 28 participants were removed because of their accuracy rate lower than 75%; only data points from 45 participants were considered in the analysis. Incorrect responses were also removed form the analysis.

3.1.2. Materials

Each participant was exposed to a total of 140 target words including real words and nonwords in four main priming conditions: identity, phonology, morphology and the control condition (Table 8). Morphologically related words shared the root morpheme. Primes were nouns and targets were triliteral verbs. In the remaining conditions, primes and targets were triliteral verbs. Each participant was exposed to 32 real words primed with real words, 32 nonwords primed with nonwords and 64 targets used as fillers, 32 of which were real words primed with nonwords and 32 were nonwords primed with real words.

In the phonology condition, we wanted to examine the phonological effect at all the levels in which we test initial and final phonological overlap. Hence, under the phonology condition, words were divided to three subconditions. In the first one, the change between the words was in the first phoneme (Phon1). In the second once, the change was in the second phoneme (Phon2) and in the third one, the change was in the third phoneme (Phon3) (Appendix C).

Table 8: Experiment 3. Priming conditions with sample prime-target pairs.

Condition		**Prime**	**Target**
Identity		fsr	fsr 'scatter,Verb'
Morphology		afsar 'scatter, Noun'	fsr
Phonology	Phon1	nsr 'blow one's nose'	fsr
	Phon2	mtˁr 'burry'	mgr 'harvest'
	Phon3	ɣʷrˁsˁ 'slaughter'	ɣʷrˁdˁ 'lie down'
Unrelated/control		ʒfil 'get nervous'	fsr

3.1.3. Procedure

The procedure in experiment 3 was identical to that in Experiment 1.

3.2. Results

Reaction Times (RTs) were measured from both target onset and target offset and the results report no difference between the two. The reported results in what follows will be based on measuring response times from target onset.

We constructed the models the same way as in experiment 1. The use of random slopes did not significantly improve the fit of the model. Random slopes by-subject report a non significant result (χ^2 (20) = 8.64, p = 0.98) and the model including random slopes by-item failed to converge.

Before we test whether a priming effect occurred in any of the priming conditions, we examined whether the model meets the linear mixed effects assumptions. A normal distribution of the residuals was observed (Figure 12) and attested by the results of a Shapiro-Wilk test of

normality (W = 0.9439, p-value < 0.001). No fixed effects were correlated/collinear. In addition, the data showed to be approximately equal across the range of the predicted values satisfying the assumption of homoskedasticity (Figure 13).

The means, standard deviations and error rates of RTs by priming condition and by lexicality are reported in Table 9 and graphed in Figure 14. A significant effect of priming condition obtains with real words (χ^2 (5)=31, p<0.001). The experimental condition was significant for the identity (χ^2 (1)=28.10, p<0.001, lowering it by 145.26ms ±25.48) and for the morphology (χ^2 (1)=8.90, p=0.002, lowering it by 76.72ms ±25.3). No significant effect for the three cases of the phonology condition with χ^2 (1)=1.07, p=0.29, lowering it by 39.35ms ±37.84) in Phon1, χ^2 (1)=3.14, p=0.07, lowering it by 61.85ms ±34.75 in Phon2 and χ^2 (1)=0.25, p=0.61, lowering it by 18.8ms ±37.4 in Phon3. There was also a significant priming effect for the identity of nonwords (χ^2 (1)=7.13, p= 0.007, lowering it by 84.52 ms ±31.07) as a result of the fast reaction to the 'no' response when hearing the nonword target (Ussishkin, Dawson, Wedel & Schluter, 2015).

Table 9: Experiment 3. Mean, standard deviation and error rates of RTs by lexicality and priming condition

Condition	Mean (ms)	Standard deviation	Error (%)
Real words			
Identity	806.66	382.88	21.33
Root	870.51	444.87	24.41
Phon1	916.11	404.58	41.5
Phon2	885.34	408.43	37.44
Phon3	936.81	374.80	37.86
Unrelated	945.55	423.20	23.43
Nonwords			
Identity	872.46	385.35	22.28
Root	953.75	414.31	25.12
Phon1	953.4	408.91	45.43
Phon2	923.38	409.29	41.34
Phon3	974.25	450.11	50.32
Unrelated	954.95	404.62	24.40

Figure 12: Experiment 3. Distribution of the residuals for real words

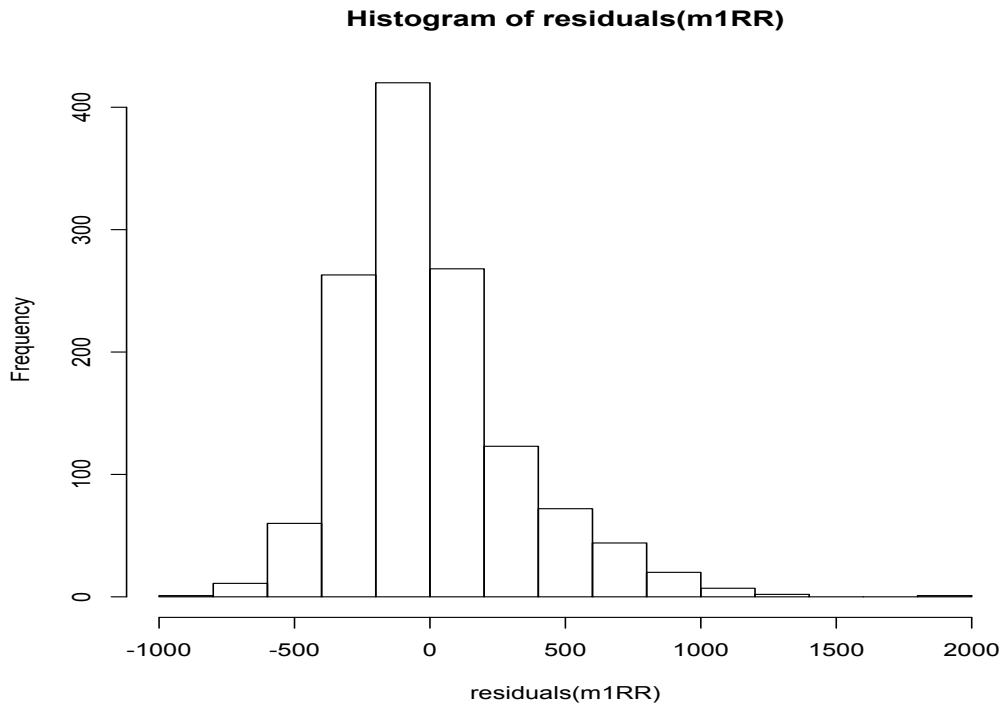


Figure 13: Experiment 3. Plot of the residuals for real words

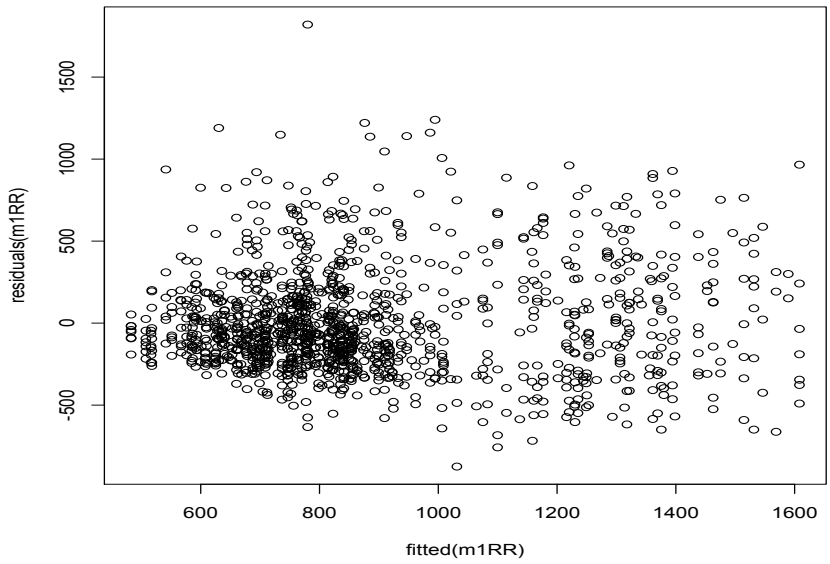
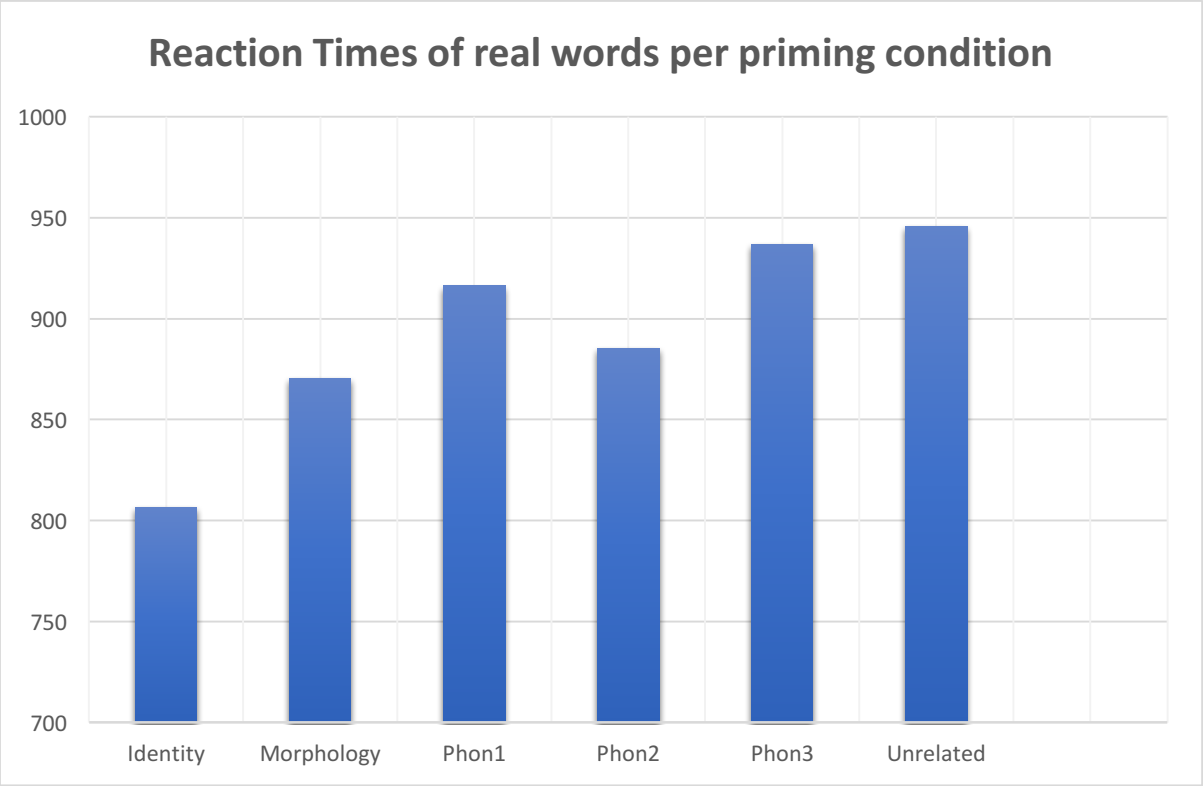


Figure 14: Mean RTs of real words by priming conditions with Phon1: change in the first phoneme, Phon2: change in the second phoneme and Phon3: change in the third phoneme.



3.3. Discussion

This experiment shows a facilitatory effect of the root confirming the previous results of experiment 2. One possible interpretation of this result is that the effect obtained is due to the phoneme clusters. However, no phonological effect was obtained in this experiment even when the words share the two first phonemes (Phon3). This suggests that what facilitates lexical access is not the shared phonological component but rather the morphemic unit itself. One more argument is that the shared root is not necessarily presented in the two words as one cluster. For example, the verb *ak^{w}l* 'stamp' primes the noun *akal* 'land', although a prefinal vowel separates the cluster of phonemes, but it does not prime the verb *ak^{w}r* 'steal', even when the two first phonemes are shared.

In the present study, we tested the degree to which phonological activation might have an impact on facilitating lexical access. We examined the phonological effect at three levels with triliteral verbs: a change in the first phoneme a change in the second phoneme and a change in the third phoneme. We predicted to have a phonological priming effect at least when the change is in the third phoneme. However, no priming obtained in neither case, suggesting that the activation of the phonological structure does not facilitate lexical access unless there is a transparent morphological relation between the prime and target.

Previous studies on different languages showed different results with respect to initial and final phonological overlap. Cited in Radeau, Morais and Segui (1995), Corina (1982) examined the role of syllable overlap in disyllabic words using lexical decision task. The results demonstrated that priming occurred with initial syllable overlap and with final syllable overlap in disyllabic words and with rime overlap in monosyllabic words. This suggests that phonological activation is insensitive to syllable position. In Radeau, Morais and Segui (1995), using auditory lexical decision and shadowing task with long and short interstimulus intervals in French, facilitation was obtained with words having final phonological overlap (sharing the last two phonemes) but not with words having initial phonological overlap (sharing the initial two phonemes), independently of word frequency. The authors concluded that priming when prime-target pairs share final phonological overlap does not tap the lexical level but rather early stages of word processing (the prelexical level). The authors added that when the initial overlap is about more than one phoneme, there is a greater chance of obtaining an inhibitory effect when using shadowing task.

The different results obtained with respect to the phonological effect might also be due to the difference in the phonological shared properties. Phonological priming has also been investigated in terms of syllable role in comparison with shared phonemes. In English,

phonological priming obtained when the words shared the final syllable and not the final phoneme. For instance, *swimming* and *farming* share the final syllable ming, but not the morpheme. They primed each other due to their shared final syllable. No priming on the other hand obtained with words like *breaking* and *smiling* having the final syllables *king* and *ling*, respectively (Emmorey, 1989). In Spanish, Carreiras (2004) showed that the initial CV syllable yielded a fast response to the target word in Spanish *ju.nas-ju.nio* but not when the two words shared only the first three letters, but not the first syllable, *jun.to-ju.nio* arguing for the important role of syllables in visual word recognition. This has been further examined in French in Carreiras, Ferrand, Grainger & Perea (2005), where the role of both the initial and final syllables was examined in addition to the role of the first shared phoneme. Results showed that priming occurred only when there was an overlap in the initial syllable but not in the second syllable. The results were confirmed using two different tasks: lexical decision and naming suggesting that the processing of bi-syllabic words is sequential. The results are in support of the claim that phonological activation is early in reading (Lukatela and Turvey, 1994a). The priming effect of the first phoneme was only obtained in lexical decision but not in naming.

One might refer to the results obtained in this study as phonetic rather than phonological (Goldinger, Luce, Pisoni & Marcario, 1992). However, knowing that in Tashlhit, we might have syllabic consonants and assuming the syllable structure in Jebbour (1996),[38] the experimental stimuli used in our experiment share different syllable structures. We have pairs of monosyllabic-monosyllabic (*frs-srs*), disyllabic-monosyllabic (*kfm, k^{w}rm*), disyllabic-disyllabic (*xmr-g^{w}mr*) and monosyllabic-disyllabic (*srm-sri*). Not only do initial and final phonemes overlap was investigated, but initial and final syllables overlap as well. Yet, the results showed no phonological priming effect. These results provide further evidence, from

[38] See section 3.2. in the General Introduction for more details on the syllable structure of Tashlhit.

new data, for the absence of phonological priming. We conclude that the morphological priming effect is insensitive to phonological overlap whether it is initial or final, contrary to the studies which claim the dependent morphological effect on the phonological overlap (Gonnerman, Seideberg & Andersen, 2007).

4. Experiment 4: Morphological Priming Effect with Vocalic vs. Consonantal Roots

In experiment 2 and 3, we found that morphological priming obtained regardless of semantic and or phonological relatedness and that morphological priming is as robust as semantic priming. The results of the two experiments showed that the root in Tashlhit facilitates lexical access suggesting that morphology plays an important role in auditory word recognition. This is a further argument for the lexical representation of the root in the Tashlhit lexicon similarly to the Hebrew, Maltese and Arabic lexicons (Deutsch, Frost and Forster, 1997, 1998, 2000; Boudelaa and Marslen-Wilson, 2001, 2005, 2013, 2015; Schluter, 2013; Al Kaabi, 2015; Gwilliams and Marantz, 2015; Ussishkin, Dawson, Wedel & Schluter, 2015; Frost, Kugler, Deutsch & Forster, 2005).

In Chapter II, further evidence was adduced for the prevalence of two types of roots in Tashlhit: vocalic and consonantal. Hence, in this experiment, we will try to examine the processing of each type and try to determine to what extent both types of roots are similarly represented in the Tashlhit lexicon. We will test whether the vocalic roots and consonantal roots are lexically represented the same way in Tashlhit. Unlike in the previous experiments, in experiment 4, careful attention was paid to the exact sample of each type of root used in the experiment.

4.1. Method

4.1.1. Participants

83 subjects participated in experiment 4 (47 females and 36 males). The age of participants ranged from 18 to 45 with the mean age 26 and the median age 26. We removed data points from 47 participants, 9 of whom reported hearing problems and 38 were excluded for their accuracy rate lower than 70%; only the results of 36 participants were considered in the analysis. We also excluded incorrect responses from the analysis.

4.1.2. Materials

Each participant was exposed to a total of 156 target words including real words and nonwords. 12 targets were used as practice items and were not considered in the analysis. Target stimuli were presented in three priming conditions: Identity, morphology and control. In the morphology condition, half of the prime-target pairs shared exclusively consonantal roots (Croots) and the other half shared vocalic roots (Vroots). Likewise, in the control and in the identity conditions, half of the targets is derived from Croots and the other half is derived from Vroots. The point was to have an equal representation of both types of roots in each condition to get valid and non-biased statistical conclusions (Table 10).

Target stimuli consisted of 36 real words primed with real words, 36 nonwords primed with nonwords, 36 real words primed with nonwords and 36 nonwords primed with real words. The last two types of pairs were used as fillers in the experiment. The participant was exposed to one of the three counterbalanced lists by priming condition using a Latin square (see experiment 1). We also generated a set of nonwords to check for identity priming. The mean duration was 479 ms for real words and 527 ms for nonwords. The experimental stimuli are presented in Appendix D.

Table 10: Experiment 4. Priming conditions with sample prime-target pairs.

	Croots		Vroots	
Condition	Prime	Target	Prime	Target
Identity	ħfr 'kick sb out'	ħfr	arm 'try'	arm
Morphology	aħfur 'hole'	ħfr	tirmt 'food'	arm
Control	ntl 'hide'	ħfr	ftu 'to pasture'	arm

4.1.3. Procedure

The procedure in experiment 4 was identical to that in experiment 1.

4.2. Results

Reaction Times (RTs) were measured from both target onset and target offset. The results of both target onset ad target offset reported no difference between the two. The means, standard deviations and error rates of RTs by priming condition and by root type are reported in Table 11 and represented in Figure 17. We created the model the same way as in experiment 1.

The use of random slopes did not improve the fit of the model. Random slopes by-subject reported a non significant result (χ^2 (20) = 13.35, p > 0.05), and random slopes by-item failed to converge. Hence, we used a random intercepts model. The residuals of our model met the assumption of normality (Figure 15), that of collinearity and the assumption of homoskedasticity (Figure 16) avoiding type I or higher type II error.

A significant effect for the experimental condition was observed (χ^2 (5)=19.53, p<0.001). Priming occurred in the identity condition for both Croots (χ^2 (1)=4.08, p<0.05, rising it by 3.59 ms ± 31.62) and Vroots (χ^2 (1)=11.9, p<0.001, lowering it by 31.44ms ±32.41).

In the morphology condition, priming occurred for Vroots (χ^2 (1)=6.3, $p<0.05$, rising it by 61.47ms ±31.69) but not for Croots.

Table 11: Experiment 4. Means, standard deviations and error rates of RTs by priming condition and by root type

Condition	Mean (ms)	Standard deviation	Error (%)
Croots			
Identity (CrootId)	631.77	299.09	21.36
Morphology (Crootmorph)	699.54	261.52	18.49
Unrelated (CrootUn)	699.54	355.59	25.14
Vroots			
Identity (VrootId)	658.21	306.98	22.27
Morphology (Vrootmorph)	695.37	282.78	19.6
Unrelated (VrootUn)	789.88	332.27	23.73

Figure 15: Experiment 4. Distribution of the residuals for real words

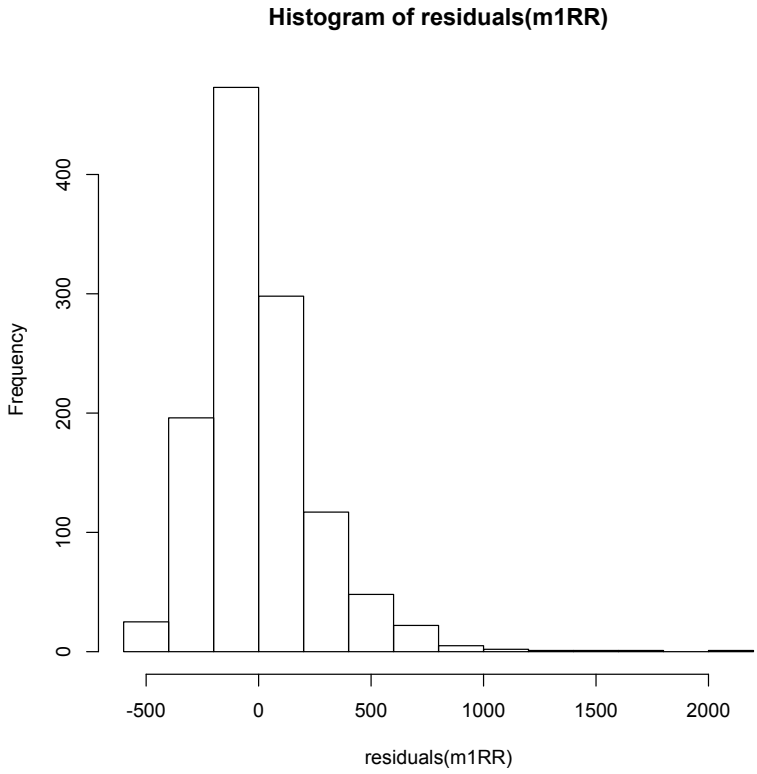


Figure 16: Experiment 4. Plot of the residuals for real words

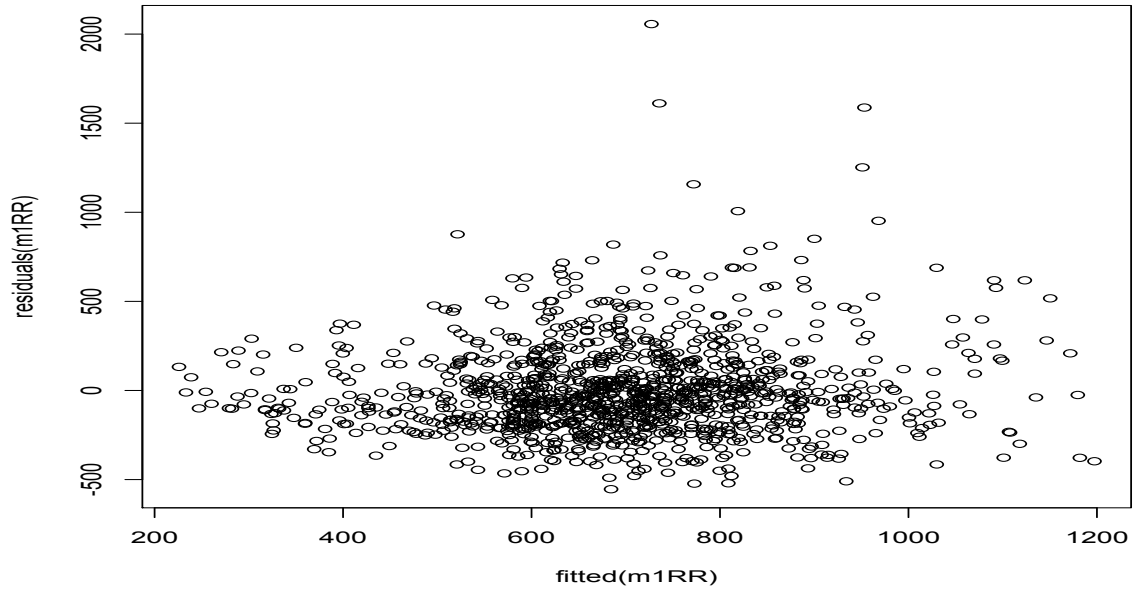
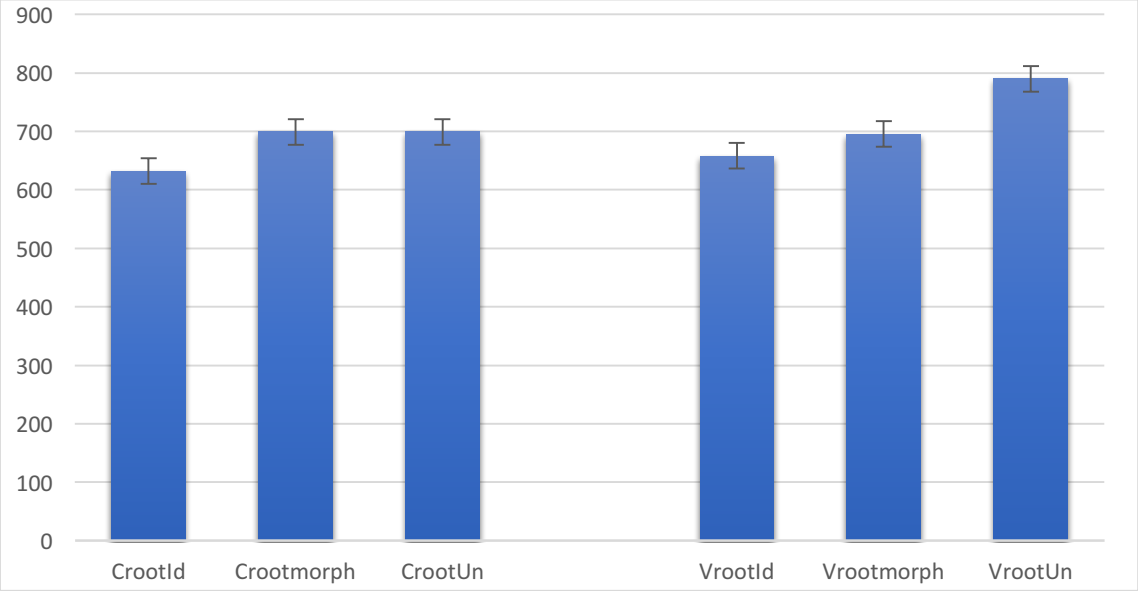


Figure 17: Experiment 4. Real word RTs by priming condition and by root type



4.3. Discussion

The results of this experiment made us ponder over the representation of both consonantal roots and vocalic roots in the Tashlhit mental lexicon. In experiment 2 and 3, a facilitatory priming effect was observed when prime-target pairs shared a root suggesting that this morphological unit plays an important role in word recognition and hence proved to be lexically represented. However, as we early presented ample evidence for the presence of both consonantal and vocalic roots in Tashlhit (see Chapter III), we tried to provide external evidence from a supraliminal priming test to examine the bipartite system of roots in the language. In experiment 4, vocalic roots facilitated lexical access unlike consonantal roots. This was unexpected for Tashlhit knowing that consonantal roots are more common than vocalic roots (see figure (63) in Chapter III).

The results achieved hitherto allow one to reach an interesting conclusion about the lexical representation of both types of roots. However, it is worthwhile to appeal to an in depth consideration of the results achieved in experiments 2 and 3, in which a robust priming effect

of the root was observed. We did not try a reanalysis of the whole process in the two experiments, but we just examined the morphologically related words. We distinguished between words sharing vocalic roots and words sharing consonantal roots to examine whether the priming effect obtained with morphologically related words was due to the effect of consonantal roots and or vocalic roots.

In experiment 2, we added another fixed effect and split the morphology condition to both Croot and Vroot to check the effect of each. For words sharing the Croot, 65 RTs were considered and for words sharing the Vroot, 51 RTs were considered. A priming effect was obtained with words sharing the Vroot (χ^2 (1)=13.6, p<0.001) but not with words sharing the Croot. These results are consistent with the results of experiment 4, in which only Vroots facilitated lexical access.

Experiment 3 showed different results with respect to Croots and Vroots. In experiment 3, most prime-target pairs shared consonantal roots. We analyzed 304 RTs of targets derived from Croots and 28 RTs of targets derived from Vroots. As is shown earlier in experiment 3, morphological priming was robust, and no phonological priming occurred. Therefore, it is of interest to check what yielded that robust priming effect. The results showed no priming for Vroots and a strong effect for Croots (χ^2 (1)=9.42, p=0.002). Although these results are inconsistent with the results we just mentioned about Croots and Vroots in experiment 2 and 4, the results of this experiment might be explained as an effect of the unbalanced samples of each root type used in the experiment. When the Croots and Vroots were equally used in deriving the experimental stimuli (experiment 2 and 4), Croots showed no priming effect unlike Vroots, which showed a strong effect. However, when most of the experimental stimuli were derived from Croots with a very few targets that were derived from Vroots (experiment 3), root priming still obtained. One tentative interpretation of these results is that Croots are less

effective than Vroots in the Tashlhit lexicon. It might be that more statistical power is needed for Croots to prime each other. Despite this, there is no doubt that Vroots are more robust than Croots. Therefore, further research is necessary.

The outcome of these experiments suggests that both Croots and Vroots facilitate lexical access. However, the lexical representation of Croots is weaker than the one of Vroots. Considerable research has been devoted to the role played by roots in word recognition process in Semitic and Indo-European languages. In priming studies in Semitic languages which showed a strong priming effect of the root, consonantal roots were the morphological units being considered in the language. In Tashlhit, however, within the root-based approach, arguments have been presented for the exclusive lexical representation of consonantal roots in the language, and others have been presented for the prevalence of both consonantal and vocalic roots in the language (see Chapter III for more details on this issue). Therefore, some sort of external evidence indeed seemed inescapable. The results we have reached so far might be due to the statistical power used in these experiments. Hence, further psycholinguistic research is deemed necessary for a better account of the internal structure of roots in Tashlhit.

The experimental stimuli used in experiment 4 have trisegmental roots. One explanation to the stronger effect of Vroots in experiments 2 and 4 might be interpreted as an effect of the bi-consonantal structure rather than the effect of the tri-segmental structure with its vocalic and consonantal elements. Boudelaa and Marslen-Wilson (2001) claim that the etymon which is a two-consonantal morphological unit facilitated lexical access even if the prime and target did not share the tri-consonantal root. Consonantal roots and vocalic roots used in this experiment might be considered as tri-consonantal and bi-consonantal roots, respectively. Theoretically, arguments for the role of the binary structure of roots have been presented in early literature. Lahrouchi (2010) examined the structure of biconsonantal and

triconsonantal roots with the forms CC, CCC, CCU and CCI. In his study, Lahrouchi claims that these verbs share a binary branching head-complement structure which has the constrained segments that are the central tenet of the verb structure. Within this proposal, verbs like *ʒlu* 'get lost' and *xmr* 'ferment' have the same binary structure. In the present dissertation, verbs like *ʒlu* and *xmr* belong to two distinct types of verbs having a vocalic root and a consonantal root, respectively. In experiment 2 and 4, both types of verbs are distinguished. Hence, the claimed common binary structure does not distinguish between the two and the consonantal structure of these roots does not does not distinguish between the priming effects obtained in this study. Only by considering the vocalic-consonantal dichotomy in the Tashlhit lexicon can we make the distinction between the two effects. The results reached about Croots and Vroots do not affect the point being made about the role played by morphology in general and roots in particular in lexical in word recognition process in Tashlhit.

5. General Discussion

The results of these three experiments confirm the hypothesis that the root facilitates lexical access in Tashlhit supporting the decomposition theory in which the root is extracted by the native speaker and allows a fast recognition of any derivation of the root in question. These results are consistent with the model of the lexicon in which roots are the lexical units that link all derivations sharing the same root morpheme. In this study, we tested whether the facilitatory priming effect obtained in these experiments is a strictly-morphological effect by controlling for semantic factors in experiment 2 and for phonological factors in experiment 3. The results of both experiments confirmed that it is the root that facilitates lexical access regardless of any other linguistic factor.

The strong effect of the root we obtained in experiment 2 is consistent with the results obtained in a number of Arabic studies. No difference was found between words sharing a root

with a transparent semantic relation and those sharing the root with an opaque semantic relation (Boudelaa and Marslen-Wilson, 2001, 2005, 2013). The reaction time to words sharing the root with an opaque semantic relation (*mataaʕun* 'commodity'- *mutʕatun* 'pleasure') was as fast as the one to words sharing the root with a transparent semantic relation (*mumtiʕun* 'enjoyable'- *mutʕatun* 'pleasure'), suggesting that the effect of morphology was strong regardless of the transparency of semantic relation. In another study, morphological priming was shown to be robust regardless of the opacity or transparency of the semantic relation even when the prime and target belonged to different grammatical categories (*ʕaqlun* 'mind' [Noun]- *taʕaqqala* 'be mindful' [Verb]) (Boudelaa and Marslen-Wilson, 2015). Further evidence for the crucial role of the root in Arabic emerges from the auditory modality in which the results showed that the root constitutes an important unit that makes word recognition facilitated (Schluter, 2013; Gwilliams and Marantz, 2015).

One of the explanations for the lack of semantic priming effect provided by Schluter (2013) is that subjects might not have been given enough time to process Moroccan Arabic verbs at the semantic level calling for future research to test for later semantic effects. We contend that the lack of semantic effect might be due to the type of semantic relation holding between the experimental stimuli (see chapter IV for more details about semantic relatedness). Following the same prime compression technique used by Schluter (2013), Al Kaabi (2015) investigated the role of roots in Emirati Arabic and found that roots facilitated lexical access in spoken word recognition whereas no semantic effect was obtained. In the same study, the strong effect of roots in Arabic was also supported by the results of an experiment on Standard Arabic using MEG recordings.

The role of morphology and semantics has also been investigated in Indo-European languages. Different results were obtained in different languages. In German, morphologically

related words that are semantically opaque (*verstehen-stehen* 'understand-stand') and those that are semantically transparent (*aufstehen-stehen* 'stand up-stand') showed indistinguishable priming effect claiming that morphological relatedness produced strong facilitation effect regardless of semantic relatedness (Smolka, Komlosi and Rösler, 2009). On the other hand, in English, pairs sharing semantics primed each other (Radeau, 1983). Some studies showed that root priming obtained in English only when there was a semantic similarity between the prime and target. In late stages of visual word recognition, sharing morphology but no semantics (*successor-success*) did not facilitate lexical access in English. For example, *govern-governor* showed a priming effect whereas *apart-apartment* showed no priming effect (Marslen-Wilson, Tyler, Waksler & Older, 1994). The authors concluded that morphologically related words that have opaque semantic relations are organized distinctly in the lexicon regardless of their morphological relation. This is explained by Deutsch, Frost and Forster (1997) as a consequence of considering semantic properties as the main clue to assess the morphological relations by English native speakers. The words (*need*) and (*needy*) for example would be assessed as morphologically related because they share meaning.

Semitic languages, on the other hand, have a different morphological system. Studies on Hebrew showed that native speakers can detect the morphological relation between words by recognizing the root independently of the semantic overlap (Deutsch, Frost and Forster, 1997, 1998). The difference between the results on English and the results on Hebrew might be due to the different priming techniques used or to the morphological system. Morphological relations are not sufficient for any storage and or retrieval of lexical items in English unlike in Hebrew (Deutsch, Frost and Forster, 1997). Further argument for the role of the root in Hebrew has also been provided in Deutsch, Frost and Forster (2000), which used the parafoveal preview information as another way to assess automatic and early stages of word recognition as masked priming paradigm. The results proved that the root facilitated both naming and lexical decision

in Hebrew and regardless of the spatial location of root letters, words sharing the root still primed each other.

Pointing in the same direction, Boudelaa and Marslen-Wilson (2005) contend that the difference between the effects of morphology, semantics and orthography cross-linguistically is due to the way native speakers of different languages encode meaning linguistically. This obviously reflects on the way the lexicon of different languages is organized. An interesting example was provided in Boudelaa and Marslen-Wilson (2005) about causativity. The latter is conveyed either lexically (*teach*: cause to learn), syntactically (*make someone happy*) or morphologically (*widen*: cause to become wide). In Moroccan Arabic, causativity is expressed morphologically through gemination (*frrʿħ* 'make someone happy') and in Tashlhit, it is expressed through prefixal morphology (*sfrrʿħ* 'make someone happy') affirming that morphological role differs cross-linguistically. In addition, the difference between English and Hebrew is not just about the morphological system but also about the phonological system. English words and morphemes are fully specified units at the morphological and phonological level, whereas in Hebrew and other Semitic languages, neither the root at the morphological level nor the word pattern at the phonological level are pronounceable units, and one cannot surface without the other. In Tashlhit, on the other hand, a large set of root units can be pronounceable forms (eg., √*nkr* : /*nkr*/ 'wake up'; √*lgr* : /*lgr*/ 'lock'). However, the results of the present study confirm the significant role of the morphological decomposition theory as is shown by Semitic languages.

Unlike in experiment 2 in which morphological priming did not significantly increase when the words shared semantic features, in Southern Tunisian Arabic and Modern Standard Arabic, in an auditory-auditory lexical decision task. Priming occurred when the words shared a root, whether their semantic relation was transparent or opaque. However, the reaction time

to words sharing the root and meaning is faster than that of words sharing the root exclusively (Boudelaa and Marslen-Wilson, 2013). This is consistent with the results obtained with English data using cross modal lexical decision tests in which using morphologically related pairs, the more semantic similarity increases, the more priming effect increases, suggesting that priming magnitude is dependent on semantic and phonological transparency (Gonnerman, Seideberg & Andersen, 2007). Bentin and Feldman (1990) also showed that words sharing roots and meaning showed a more robust repetition effect than words sharing the root but no meaning. In another study on form and meaning, Pastizzo and Fieldman (2009), cited in Kielar and Joanise (2011), the results showed that priming was greater in items sharing both form and meaning (*boat-float*) than in items sharing just form (*coat-float*) or just meaning (*swim-float*). In recent studies on English, using cross modal priming and ERP (Event-Related Potentials), the results found that in late interval time, morphological effects were more robust when the words shared both morphology and semantics claiming that "morphological relatedness is graded rather than absolute" (Kielar and Joanise, 2011). This is in keeping with the convergence of codes theory which claims that morphology emerges from overlapping semantics, phonology and orthography. However, it is important to note that the shared morpheme in Kielar and Joanise (2011) is not the root but the suffix. Previous research on suffix priming effect showed that words sharing the same suffix did not prime each other (Emmorey, 1989). Hence, the type of morphological relation is crucial in word recognition process. The morphological relation tested in Kielar and Joanise (2011) is different from the morphological relation we investigated in the present study. Unlike suffixes, roots showed to play a significant role in lexical access facilitation.

In controlling for phonological factors in experiment 3, the results were consistent of with the results of previous studies on phonological priming in Arabic. One of the studies, that used cross modal priming paradigm, showed that words having a phonological overlap did not

prime each other, whereas words sharing morphology primed each other even if the two words lack any semantic or allomorphic shared properties (Boudelaa and Marslen-Wilson, 2004). In an auditory-auditory lexical decision task on Southern Tunisian Arabic and Modern Standard Arabic, phonological priming has been tested using words sharing two or three consonants but not the root. For instance, the words *mæzruub-mazirʕah* 'in a hurry-farm' share the consonants (*mzr*) but they have the roots √*zrb* and √*zrʕ*, respectively. The results showed that no phonological priming occurred in this condition (Boudelaa and Marslen-Wilson, 2013). A further argument for the inhibitory effect of phonology emerges from a later study by the same authors on Standard Arabic using cross modal priming experiments. The study tested phonological effect using pairs sharing two to three consonants with no morphological and no semantic overlap (*samiidun* 'semolina'- *ʃamsun* 'sun'). The results showed that phonological effect did not occur in Arabic and hence has no effect on the root priming effect obtained (Boudelaa and Marslen-Wilson, 2015).

The absence of phonological priming has also been attested in Indo-European languages. Marslen-Wilson, Tyler, Waksler & Older (1994) investigated to what extent phonological factors facilitate lexical access and whether phonological properties are stored in the mental lexicon of English. In an experiment where only morphology and phonology were tested, the words that were only phonologically related but not morphologically related did not prime each other unlike words which were morphologically related. Two words sharing morphological features primed each other regardless of whether they shared phonological properties or not. Words like *friendly* and *friend* (sharing both morphology and phonology) would prime each other but not words like *tinsel* and *tin* (sharing phonology but no morphology). This suggests that phonological overlap does not yield any priming effect unless some semantics or morphology is shared between the prime and target pairs. On just phonological priming, using auditory lexical decision task on English, the prime-target pairs

were examined at the phonological condition at three levels: Either they shared the first, second and third phonemes, the first and second phonemes or just the first phoneme. The experimental stimuli were divided to high frequent and low frequent items, and no effect was noticed in the case of initial phonological overlap (Slowiaczek and Pisoni, 1986).

Within the root-based approach we argue for herein, we distinguished between two types of roots: consonantal and vocalic. Native speakers made a fast response to target words when preceded by primes sharing vocalic roots (experiments 2 and 4) and a fast response to targets when preceded by primes with which they shared consonantal roots (experiment 3). Vocalic roots showed a more robust priming effect than consonantal roots. However, based on the results of experiments 2 and 4, on the one hand, and experiment 3, on the other hand, further behavioral tests with regard to the representation of consonantal roots and vocalic roots is required. We believe that these tentative conclusions about root structure in Tashlhit do not deny the fact that the root as a morphological unit rather than a phonological structure is the basic tenet for the model of lexicon organization.

It is of interest to point out that morphological priming effect can be interpreted differently. In a word-based model, priming effect suggests that the lexicon is organized through lexical entries which contain whole words having a set of information. In a morpheme-based model, morphological priming effect indicates that the root is the lexical entry that facilitates the word recognition process. A study on Spanish showed that morphologically related words are accessed distinctly during spoken word recognition through stem morphemes arguing that stems are the stored morphemic units in the Spanish mental lexicon (Gwilliams, Mohannan and Samuel, 2015).

6. Conclusion

The cross linguistic difference in the organization of the lexicon might be due to the richness of the language morphology or to the "form-meaning regularities" particular to the language. A morphologically rich language like German might have biased the representations of the structures in the lexicon. Furthermore, a language in which the overlappings of form and meaning are not idiosyncratic but rather regular mappings of morphology and semantics might have an influence on the lexical representations. We assume that Tashlhit has more overlappings of form and meaning than distinct structures. In experiment 2, we had 20 words that shared both the root and semantic features and 16 words sharing just the root with no semantic overlap.

In the present study, we argued for morphological decomposition. Roots showed to be facilitating lexical access in Tashlhit as has been shown in Hebrew, Arabic and other languages. Hence, we argue for a model of lexicon organization in which root morphemes are extracted. The organization of roots in the model we advocate here is insensitive but related to semantic relatedness and independent of phonology. The results of this study are consistent with the localist view of the mental lexicon which assumes that morphologically related words are interconnected in the lexicon through the morpheme they share as opposed to the nonlocalist view of the mental lexicon which contends that morphological effects are due to the correlation between phonological, orthographic and semantic effects and not to morphology per sa (Gonnerman, Seideberg & Andersen, 2007; Kielar and Joanise, 2011). A theory on word processing would require a view on how native speakers of all and different languages access their lexicon. Hence, this study is a step forward for a wide scope of future research on a newly explored language from a psycholinguistic perspective.

GENERAL CONCLUSION

We now turn to present the main conclusions we have reached so far in this study. The main objective was to investigate the role of the 'root' as a morphological unit from both theoretical and psycholinguistic perspectives. Assuming that extralinguistic factors support what has been theoretically argued for, we conducted some priming tests to present ample external evidence for the role played by roots in the Tashlhit morphology. We presented facts from data of Tashlhit, particularly the variety spoken in the area of Ighrem N'Ougdal and its surroundings.

In Chapter I, we presented the main points about the morphology and the phonology of the language. We sketched the basic facts about the verbal and nominal morphology. we presented the basic facts about the inflections and derivations of verbal morphology (inflections: aorist, perfective, perfective negative and imperfective; derivations: causatives, reciprocals and passives) and those of nominal morphology (inflections: gender, number and state; derivations: action nouns and agentive nouns). We also reviewed the main studies devoted to the root structure in Semitic, Indo-European and Amazigh languages focusing on the root-based and word-based approaches. In this study, we argued for the root-based approach. However, we clearly do not deny that a theory in which both approaches are adopted would provide a better understanding of the morphological structures of the language. In this chapter, We also discussed the two contrasting morphological approaches: the root-based and word-based. As our argumentation advocates the significance of the root morpheme, a detailed discussion on the root-based theory and its alternative is necessary.

Under the premises of a root-based approach, we contend that roots in Tashlhit have a bipartite system. We referred to the two types of Tashlhit roots as consonantal and vocalic. The former is the type of roots common in Hebrew, Arabic and other Semitic languages in which

only consonants are the root components. Vocalic roots are the root type in which both consonants and vowels compose the root morpheme.

In the second chapter, we reviewed the basic theoretical and experimental frameworks under which we based our analyses. We briefly presented the basic points about the computation theory (Optimality Theory) under which we based our analysis, and we introduced the experimental tests we adopted in the present study. We tried to use non masked/supraliminal priming experiments with the end of testing the effect of morphology in general and roots in particular in the Tashlhit lexicon. We tried to answer the question of whether the root plays any role in facilitating lexical access in Tashlhit as it has been shown in a number of languages. We argued for our use of the auditory modality and showed that a number of subliminal or masked experiments using different priming techniques were not effective in the language. Hence, we conducted the experiments using supraliminal priming in which the prime was audible.

In Chapter III, we presented further evidence for the importance of the root as a morphological unit in understanding Tashlhit morphological structures. We proved that vocalic and consonantal roots co-prevail in the Tashlhit lexicon. We argued that the vocalic element in the root morpheme is not position-constrained but, rather, can occupy the initial, medial and or final position of the root. We reviewed some of the works that argued for the vowel-final root in the language, and we presented additional arguments for this type of roots from i-final verbs. The latter have been considered in previous studies as idiosyncratic and did not receive fairly enough treatment. Arguments were presented from both verbal and nominal morphology. We argued that like u-final verbs, i-final verbs also have consonant final and vowel final roots. We presented a unified Optimality Theoretic analysis for the perfective morphology of verbs having consonantal and vocalic roots. We claimed that the perfective morphology of these

verbs is a result of the following ranking schema of constraints: *μ/G>>R-ANCHOR>>RM>>IDENT-high. RM drives the vowel ablaut appealed to by perfective morphology and IDENT-high ensures the vowel quality from the input. It is violated by all verbs undergoing vowel ablaut because of the back vowel that surfaces in final position. The constraint *μ/G does not allow glides to surface in the head mora of a syllable and hence they do not surface in the final position of verbs. The Right-ANCHOR constraint, on the other hand, requires the right edge of the root to coincide with the right edge of the stem. Hence the final element of the root either vocalic or consonantal is ensured by this constraint in the perfective form of the verb.

We added further evidence for the vocalic type of roots in Tashlhit by focusing on roots having a medial vowel. We argued that the medial vowel in some verbal forms cannot be present in these forms as a result of an augmentation process nor of a templatic requirement. Only by assuming that these vowels have a radical affiliation can they be accounted for. Section (4) in the same chapter provides additional arguments for the presence of vowels in Tashlhit root structure. We studied the case of the construct state of nominal forms and proved that a reference to the root structure, be it consonantal or vocalic, is mandatory to account for the irregularities of the construct state in the language. In our constraint-based account for the construct state of nouns in Tashlhit, Positional faithfulness constraints MAX-Root and MAX-Affix were crucial to our analysis in addition to ALIGN constraints, DEP, *VV and IDENT[voc]. ALIGN constraints explained the prefixal nature of the construct state affix in masculine forms and explained the presence of the prefix in feminine forms, whereas positional faithfulness constraints preserve the root elements, be they vocalic or consonantal.

Implications of the root structure we argued for have also been discussed in chapter III in which we presented a representative graph with both consonantal and vocalic roots in

Tashlhit. We also discussed the contribution of our argumentation for the root structure to morphological theory in general.

Chapter IV introduced the priming technique used in the four experiments we conducted. We reported the different subliminal priming techniques which did not yield any priming effect, not even in the repetition effect. We also reported the results of the pre-tests used for stimuli selection: frequency and semantic surveys. The former was done on a 7 point scale and used in all the experiments we conducted so far. The semantic survey, on the other hand, was designed based on a two-parts procedure. Part 1 was meant to generate as many possible items sharing the same semantic features as the given word, and part 2 was about selecting the highly semantically related items (the ones sharing highly semantic features) on a 5 point scale from 'not at all semantically similar' to 'highly semantically similar'.

Chapter IV also tests whether semantic features have some sort of lexical representation in Tashlhit. The results showed that semantics has a facilitatory effect at late stages of the word recognition process. A facilitatory effect of semantics has shown to be common in Indo-European languages (Emmorey, 1989; Holcomb and Neville, 1990; Blumstein et al., 1982; Slowiaczek, 1994) but not in Semitic languages (Schluter, 2013; Deutsch, Frost and Forster, 1997; Ussishkin, Dawson, Wedel and Schluter, 2015). We explained that the different results with regard to semantic priming effect might be due to the type of semantic relatedness adopted in the experiments. In addition, a further examination of the role of semantics using some masked priming is mandatory to test to what extent the facilitatory priming effect of semantics is automatic.

Chapter V is about the morphological priming effect and more particularly the root priming effect in Tashlhit. To the end of testing the strictly-morphological effect, we had to control for semantic (experiment 2) and phonological factors (experiment 3). In experiment 2,

3 and 4, we adopted the same procedure as in experiment 1. The results of experiment 2 showed that a facilitatory priming effect occurred when the words shared the root regardless of whether they shared a transparent or opaque semantic relation suggesting that morphology alone can produce priming. Furthermore, morphological effect and semantic effect were indistinguishable. The strong effect of the root has been confirmed in experiment 3, in which phonological effect has been tested. The results of experiment 3 showed an inhibitory priming effect of phonology. The phonological properties shared between the words did not facilitate lexical access. Neither initial nor final phonological overlap helped in obtaining a facilitatory priming effect; Only words sharing the root could prime each other but not words sharing either the second and third phonemes, the first and third phonemes or the first and second phonemes. This suggests that unlike phonology, both morphological structures and semantic features are lexically represented in Tashlhit.

We further investigated the role of the root morpheme in word recognition by testing the impact of the root structure on the strong priming effect we obtained in experiments 2 and 3. We distinguished between consonantal and vocalic roots and tested each of them separately by the same participant in the same experiment. The results showed that an equal representation of both types of roots showed that only vocalic roots obtained a facilitatory priming effect unlike consonantal roots which had a non significant effect. In addition, when the experimental stimuli were mostly derivations of consonantal roots, a root priming effect still obtained showing that also consonantal roots can prime each other. We contend that the different results we got with regard to consonantal and vocalic roots might be related to the power used in these experiments. Further research on this issue is required. However, we do not feel that these problems present an insuperable barrier and believe that the results achieved in this dissertation give significant grounds for continuing along the lines proposed.

To wrap up, the results of our theoretical and empirical analyses show that the root is an essential morphemic unit that plays an important role in the understanding of language processing. We prove that roots in Tashlhit have some psycholinguistic reality and, hence, they have significant implications for the organization of the Tashlhit lexicon. We obtain the same result with semantic features that show a significant priming effect, suggesting the lexicality of semantic features in the Tashlhit lexicon. Only phonological properties do not facilitate lexical access, leading to the conclusion that phonology has no role in word recognition processes. We also argue for the coexistence of both consonantal and vocalic roots in the Tashlhit lexicon.

Data from Tashlhit supports the decomposition theory in which root morphemes constitute part and parcel of the models of the lexicon organization. A root-based approach seems to better account for certain morphological structures in Tashlhit. In addition the model of lexicon organization we advocate in the present study consists of both types of roots, consonantal and vocalic. The bipartite system of Tashlhit roots does not deny the role that morphology plays in language processing. Both theoretical and empirical evidence support this claim. Tashlhit adds to the Semitic languages: Arabic, Hebrew and Maltese in which morphology, particularly the root morpheme, is the default component that native speakers extract to fastly recognize derivations of the same root. On the other hand, the strong semantic priming effect obtained in this study does not typologically classify Tashlhit with Semitic languages but rather with Indo-European languages.

As is already mentioned, to our knowledge, this work is the first to treat Tashlhit or a variey of Amazigh in general from a psycholinguisic perspective. Hence, it is of interest to mention a few points about the experiments that are newly exposed to the community who speak the language as their mother tongue. The whole task was strange enough for the

participants. For every participant, we provided a laptop in which the experiment was installed. The fact of asking the participant to do a task on a laptop was not always a welcomed idea. Some of the participants thought that the point was to take their fingerprints. Others thought that it might be saving their personal info including their photo. Another issue also concerned the accuracy rate of the participants responses. The instructions were explained sometimes, more than twice, to the participant; yet, the data points of many participants were removed for their lower accuracy rate. This might be due to the fact that they could not clearly understand the instructions or it might be due to other non linguistic factors such as tiresome, lack of concentration or just to the reaction of the participant to the first time exposure to such task. We also could not fix a specific time in which all the participants can do the task, which would have been ideal. Participants ran the experiments whenever they were free for some time and wherever they were. Hence, the recruiter had to move from one place to another with the laptop to join the participant in a quiet place where he or she can do the task.

The results we have got so far about the semantic, morphological and phonological effect are obtained using nonmasked/supraliminal priming. As a reminder, the masked priming experiments we tried did not yield a repetition priming effect. This means that even when the prime and the target words are identical, this did not help the participant to recognize the target word rapidly. It took the participant a long reaction time as is the case when the target is preceded by an unrelated word. Only datapoints of participants with an accuracy rate higher than 75% were analyzed, suggesting that only the responses of the participants who understood the instructions were considered. Even with different compression rates of the prime, the results showed that the masked priming techniques we used are ineffective. Thus, further research is required to find out a masked priming technique that would work with Tashlhit data. Furthermore, the facilitatory effect of semantics and morphology report the effects at late stages

of language processing. However, this is to be further examined using some new technique of masked priming to investigate to what extent these effects are automatic.

The conclusions we have reached so far are subject to the variety of Amazigh we investigated. However, for a complete view on how the theory of word recognition process works, we should investigate how the mental lexicon is accessed and processed in all and different languages. Hence, this study paves the way for further research on other Amazigh varieties, mainly on Tarifit and Tamazight.

We also proved that in Tashlhit, we have two types of roots: consonantal and vocalic. However, more research is necessary to further examine the lexical representation of both types of roots. In addition, a high number of roots are borrowings from Moroccan Arabic. So, it might be intrighuing to examine the lexicality of these roots, and to test to what extent the native and borrowed roots are similarly represented in the Tashlhit lexicon.

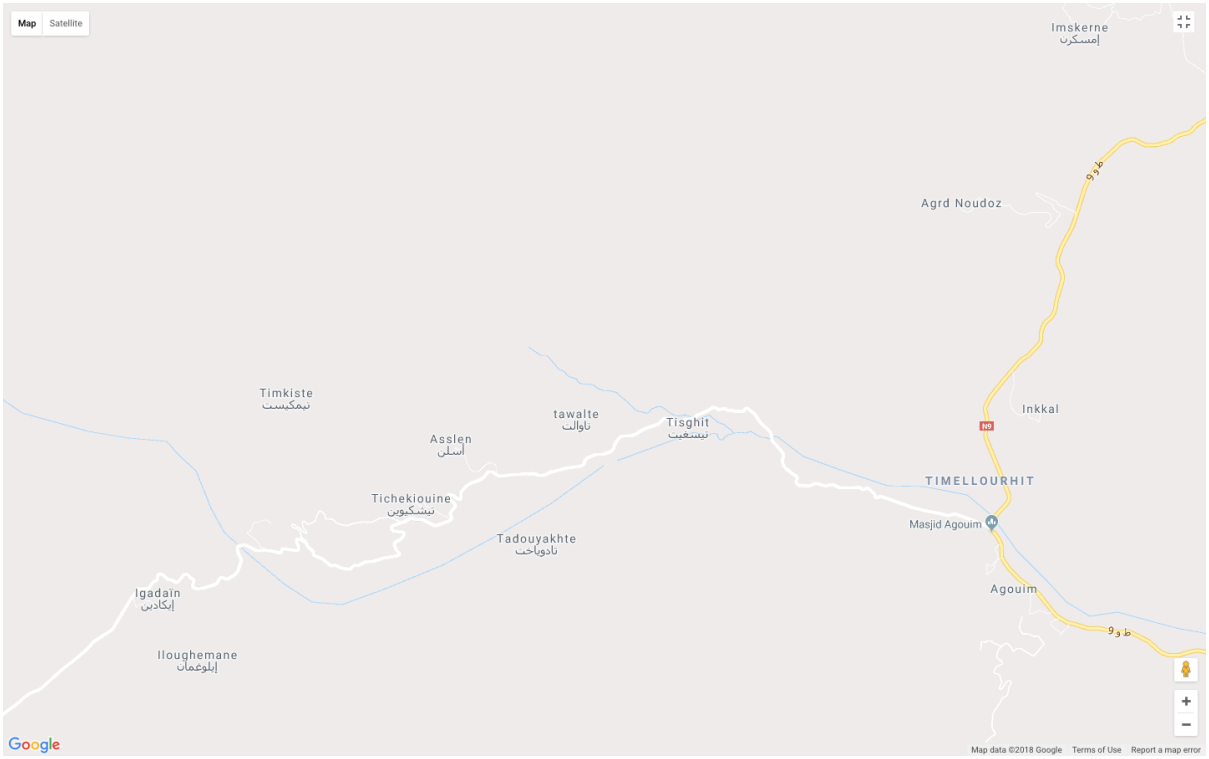
In addition, as we have already mentioned in an earlier section, plurals in Tashlhit are formed based on the singular for. This is an output-output process rather than an input –output process. We might want to say that a reference to the root is mandatory to account for the vowel that is maintained in all the forms. However, plural formation is still a complex issue to reach constructive conclusions.

We also cited a work that has challenged the root-based theory in Tashlhit and Arabic. This work is intriguing inasmuch as it brought up the linguistics behavior of the perfective morphology with respect to French borrowing. We contend that for a more understanding of the processes of the native language and borrowings, we need to conduct further research under this topic and examine to what extent can the root or the stem be of relevance to the understansing of morphological structure.

Another important point is of concern to secret languages. The works we have reviewed so far about these languages have supported the consonantal root per sa. However, it would be of great interest if we can examine new data to challenge or support the consonantal/vocalic root.

Figure 18: Location of the research area

Some towns in Tamstinte tribe



Some towns in Tidili tribe

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Appendix A

Experiment 1: Real Words

target		Semantics		Control	
tazzwit	'bee'	warˤzzˤan	'wasp'	adˤadˤ	'finger'
wabiba	'mosquito'	izi	'housefly'	tiskrt	'garlic'
igijjz	'calf'	akntˤurˤ	'bull'	ibruri	'graupel'
akazzˤaj	'chick'	afullus	'chicken'	awri	'dry plants that grow in the mountains (eaten by sheep and cows in winter'
idukan	'slippers'	turˤzˤijin	'sandals made of leather (for men)'	arˤħbij	'hallway'
tˤagja	'oriental islamic cap'	tarazara	'hat'	amksa	'shepherd'
aʒllabij	'djelaba'	aqʃʃab	'kamis (long cloth mostly for men)	taswikt	'walnut tree'
tattˤrˤft	'melhfa made of lace'	amlħaf	'melhfa (special cloth for women)'	imzizzl	'pancake'
zzif	'scarf'	aʒɣaɣ	'cloth'	tasa	'liver'
izikr	'rope'	akʷrraf	'long piece of cloth used to tie'	ssbaɣt	'paint'
tumzˤin	'barley'	irdn	'wheat'	atfl	'snow'
wamsa	'anise'	lkmmun	'cumin'	annrar	'spacious area outside home/place used to use for harvest'
aɣʷrrˤaf	'mug'	lkas	'glass'	timqqit	'drop'
tazakat	'wicker plate with a cover (where bread is served)'	isggʷi	'wicker plate (used to purify wheat)'	izˤni	'nut'
tasksut	'colander made of metal particular to couscous'	tasustit	'strainer'	awal	'talk'
taffarnut	'traditional oven used to cook a	takatt	'traditional oven made of soil used to cook bread'	isdal	'blanket'

	particular bread (tannurt)’				
aglzim	‘poleax’	aʃaqqur	‘axe’	tabrat	‘letter’
ttˁaʒin	‘tajin’	anxdam	‘clay pan’	amdlu	‘cloud’
aʒnwij	‘big knife (slicer, scimitar)’	lmus	‘knife’	tazra	‘necklace’
baddaz	‘couscous made of cornmeal’	sksu	‘couscous (made of semolina)’	arˁzzˁum	‘opening’
taħrirt	‘soup made of tomato sauce and some legumes’	askkif	‘soup made of grains’	annli	‘millet’
tannurt	‘tortilla’	tawnift	‘a particular type of bread'	azˁalˁim	‘onion’
taʒlaʃt	‘curdled milk’	aɣu	‘buttermilk'	afus	‘hand’
iʒwwan	‘wind’	asˁmmidˁ	‘cold'	afsaj	‘opening’
adrar	‘many high mountains’	aɣulid	‘big rock/ mountain’	aʒmil	‘favor’
lhif	‘heat’	lħma	‘warmth’	agzzar	‘butcher’
lfsˁsˁa	‘Alfalfa'	tuga		taɣawsa	‘affair’
izri	‘mugwort'	asir	‘rosemary'	anu	‘well of water’
izuknni	‘thym’	flajju	‘pennyroyal'	aɣarˁasˁ	‘road’
igrtil	‘strawmat’	tazˁrˁbˁijt	‘carpet’	afud	‘knee’
ahidˁurˁ	‘sheep skin’	alˁɣʷmadˁ	'cow leather'	tasˁsˁfsˁaft	‘willow tree’
taʃttˁabˁt	‘used to refer to the broom made of Doom plant but now it refers to any broom’	ifsski	‘besom'	usman	‘lightning’
anas	‘bucket’	tafdˁna	‘big galvanized bucket used in steam baths’	tazˁalˁlˁit	‘prayers’
nndˁm	‘a capella’	aħwaʃ	‘singing and dancing’	taqqajt	‘walnut’
tagnza		tallunt	‘sifter'	ʃʃariʒ	‘pool’
targa	‘small and restricted river’	asif	‘river'	aħlas	‘saddle’

Experiment 1: Nonwords

target	Semantics	Control
uʃnam	tanʃla	tihsi
askam	taʃuʃtit	abbal
alga	taʃɣra	anʒˁawbˁ
aʒˁrˁasˁ	aʃlbun	aɣurib
amaʃ	agʒʒal	tilki
tagmʒa	adla	aɣnar
iʒukmmi	aʃnnib	tiʃklt
asˁbˁlˁ	agmtul	tikijjst
idluli	tarrumt	amklaʒ
akltir	taʃlba	tangma
talɣa	iblim	tiʒmi
izwwam	tarxsa	tangla
tammult	tiħri	tiʒwi
agrʒim	tilˁbˁi	tanbla
agʷllaf	anxbam	taʒarrit
taʃkʃut	taʒˁlˁdˁijt	amlar
taħddˁut	tiɦmi	ardaz
aɦsul	asaqqul	amu
iʃbar	aʒil	aʃluʃ
wanʃa	iʃkkʷi	tamkla
tabˁlˁujji	axmil	amʒa
taʒakat	amʃuʃ	azˁttˁarˁ

asrax	aflig	tiɣʷlʃi
iʒikl	anrħaf	tarust
tafrarrajt	tiɦri	aʃlab
attˤlf	azdal	ixʷlˤzˤam
aʒrradij	tilʒi	aɣrˤurˤ
aʒʒbar	amlaʒ	tanwla
agaʒʒˤaj	axusi	alˤttˤarˤ
tarˤdˤʒˤa	azraf	arrxf
wadida	aʃɣan	aɣʒuʒ
adzal	anmɣar	alʃuʃ
takmsa	tiftirt	aɦluj
tanklaʃt	alˤdˤaʒˤ	anʒˤbˤaɣ
aɣʷlˤadˤ	afsan	arˤdˤaʒˤ
aʃmaj	aʒʒal	iʒmi

Appendix B

Experiment 2: Real words with morphologically related words having a transparent semantic relation

Target		**-Root+Sem**		**+Root+Sem**		**Control**	
asqqal	‘big mountain hard to climb’	azlag	‘small mountain	sqql	‘tan on the top of the mountain’	adˁadˁ	‘finger’
taʃttˁabt	‘broom’	ifski	‘besom’	ʃttˁb	‘sweep’	amzdaɣ	‘cemetery’
azlif	‘dry plants smaller than ‘awri’’	awri	‘dry plants’	zlf	‘beat’	asttix	‘crashing’
akʷrram	‘cold’	asħmim	‘freezing’	kʷrm	‘get cold’	tiftilt	‘rolled tissue used to make fire’
afsaj	‘opening	afukku	‘trick’	fsi	‘open’	ammraz	‘wound in the head’
awal	‘talk’	aqqur	‘noise’	sawl	‘talk (V)’	taxmirt	‘yeast’
igran		iɣunan	‘gardens’	grn		isdal	‘blanket’
amkraz	‘plow (tool)’	awallu	‘old tool hanged to animals used to plow’	krz	‘plow’	tazra	‘necklace’
azil	‘sight’	anfa	‘light’	zzil	‘see’	arˁzzˁum	‘opening’
azuzwu	‘cool weather’	asˁmmidˁ	‘cold’	zwu	‘dry’	annli	‘barley’
aɣʷrrˁaf	‘mug’	lkas	‘glass’	ɣʷrˁf	‘poor’	akntˁurˁ	‘bull’
lħma	‘warmth’	lɦif	‘heat’	ħmu	‘heat(V)’	aʒmil	‘favor’
zzif	‘scarf’	aʒɣaɣ	‘towel for cleaning	zijf	‘dry using a towel’	agzzar	‘butcher’
lbriħ	‘calling loudly’	laʕjadˁ	‘screaming’	brrħ	‘call loudly’	anu	‘well of water’
tamaɣa	‘fight’	tazˁit	‘berating’	maɣ	‘fight (V)’	aɣarˁasˁ	‘road’
tazdmt	‘bundle of firewood’	takrrust	‘bundle of clothes’	zdm	‘gather firewood’	afud	‘knee’

irkan	‘dirt’	abdduz	‘trash’	rku	‘dirty(V)’	tasˁsˁfsˁaft	‘willow tree’
tamgra	‘harvest’	tiwizi	‘gathering of women to harvest’	mgr	‘harvest (V)’	tazˁallˁit	‘prayers’
tag^{w}mmimt	‘small amount of water’	timqqit	‘drop’	ag^{w}m	‘draw water from well’	ʃʃariʒ	‘pool’
aħwaʃ	‘singing and dancing’	nndˁm	'a capella’	ħuʃ	‘sing and dance’	aħlas	‘saddle’

Experiment 2: Real words with morphologically related words having an opaque semantic relation

Target		**-Root+Sem**		**+Root-Sem**		**Control**	
ifri	'pool'	amda	'sink'	fru	'separate'	tiskrt	'garlic'
aħʃmij	'child'	afrˤuɣ	'boy'	ħʃʃm	'asahme'	ibruri	'graupel'
ʃʃˤrˤitˤ	'	izikr	'rope'	ʃˤrˤtˤ	'require'	afras	'radish herb'
afullus	'chicken'	akazzˤaj	'chick'	flls	'be stubborn'	imzizzl	'pancake
ikru	'ram'	tili	'ewe'	kru	'rent'	tasa	'liver'
asli	'groom'	argaz	'man'	sli	'touch'	atfl	'snow
azˤrˤu	'rock'	aɣulid	'big rock/mountain'	zˤrˤ	'look'	addar	'cowshed/ pen'
tirmt	'food'	allas	'afternoon meal'	arm	'try'	izˤni	'nut'
afiddun	'burnous'	aslfiam	'cape'	fiddn	'calm'	aħanu	'shop'
talʕint		taɣbalut		lʕn	'curse'	amdlu	'cloud'
ʃʃnnaq	'something used to hang'	algamu	'muzzle'	ʃnnq	'hang'	azˤalim	'onion'
tagant	'forest'	lxla	'jungle'	gn	'sleep'	afus	'hand'
aħfur	'big hole'	aqʷʒi	'small hole'	ħfr	'kick'	taɣawsa	'affair'
agru	'small frog'	alfsa	'big frog'	gru	'pick'	usman	'lightning'
taffarnut	'oven to cook tortilla'	takatt	'oven to cook bread'	frn	'sort'	taqqajt	'walnut'

Appendix C

Experiment 3: Real Words

Target		Phonology			Morphology		Control	
frs	'sharp'	srs	'put down'	Phon1	afras	'raddish herb'	rʃq	'have fun'
xmr	'fermen t'	gʷmr	'tease'	Phon1	taxmirt	'yeast'	nɣd	'grind'
zˤbˤrˤ	'hurt'	sˤbˤrˤ	'be patient'	Phon1	azˤbbˤarˤ	'stomachache'	nqqʃ	'tattoo'
ɣwdˤrˤ	'betray'	dˤrˤ	'fall'	Phon1	aɣddˤarˤ	'cheater'	xtm	'compl ete'
rˤdˤl	'lend'	mdˤl	'burry'	Phon1	arttˤal	'loan'	zɦr	'have fun'
krz	'plow'	mmrz	'wound in the head'	Phon1	amkraz	'plow (tool)'	brˤm	'roll'
xdm	'work'	zdm	'gather firewoo d'	Phon1	axddam	'worker'	rˤzˤm	'open'
ʒdr	'burn'	bdr	'mentio n'	Phon1	aʒdar	'burning'	lˤbˤʒ	'crash'
fsr	'scatter'	nsr	'blow one's nose'	Phon1	afsar	'scatter (N)'	ʒɦl	'get mad'
ftl	'roll'	ntl	'hide'	Phon1	tiftilt	'rolled tissue'	rbħ	'win'
mgr	'harvest'	mtr	'burry'	Phon2	tamgra	'harvest (N)'	ʒllx	'mess'
sbɣ	'paint'	stɣ	'crack'	Phon2	asbbaɣ	'painter'	ʃrk	'share'
ħfr	'kick'	ɣfr	'forgive'	Phon1	aħfur	'hole'	slɣ	'stick'
rkm	'curdle'	rgm	'gossip'	Phon2	tirkmin	'turnips'	ʃtˤn	'worry'
nkr	'wake up'	ndr	'moan'	Phon2	tankra	'waking up'	msl	'coat'
gnu	'sew'	gru	'pick'	Phon2	tigni	'sewing'	nql	'move'
kʃm	'enter'	kʷrm	'freeze'	Phon2	akʃʃum	'entering'	gzzr	'bucth er (V)'
ħgrˤ	'undere stimate'	ħzzˤrˤ	'reconc ile'	Phon2	aħggarˤ	'arrogant'	tlf	'lost'
ħzzm	'take care/tea se'	ħʃʃm	'shame'	Phon2	aħzzam	'belt'	qrrˤb	'get near'

lgr	‘lock’	lwr	‘escape’	Phon2	talgrawt	‘locking’	dˁlm	‘blame’
srm	‘peel’	sri	‘lick’	Phon3	asram	‘zest’	ndm	‘regret’
frg	‘border’	frn	‘sort’	Phon3	afrig	‘border(N)’	xlˁdˁ	‘mix’
akʷl	‘stomp’	akʷr	‘steal’	Phon3	akal	‘land’	xʷmʒ	‘spoil’
arm	‘try'	ars	‘clean’	Phon3	tirmt	‘food’	ɦddn	‘calm’
brrħ	‘call loudly’	brrd	‘make cold’	Phon3	lbriħ	‘calling loudly’	xnng	
kʷms	‘tie’	kʷmz	‘scratch’	Phon3	akʷmmis	‘tie (N)’	fdˁh	‘expose’
ɣʷrˁsˁ	‘slaughter’	ɣʷrˁdˁ	‘lie’	Phon3	tiɣrˁsˁi	‘slaughter (N)’	nħs	‘upset’
sɣl	‘measure’	sɣi	‘oblige’	Phon3	asɣal	‘any tool used to measure’	kʷrf	‘tie’
frrˁʃ	‘carpet (V)’	frrˁʒ	‘help’	Phon3	lfrˁaʃ	‘carpet N/bed)’	zdɣ	‘live’
nʒħ	‘win’	nʒm	‘save’	Phon3	nnaʒaħ	‘success’	rkkz	‘dance’
zlf	‘beat’	zlɣ	‘take’	Phon3	azlaf	‘bowl’	dˁmn	‘guarantee’

Experiment 3: Nonwords

Target	Phonology		Morphology	Control
ɦsl	fsl	Phon1	aɦsul	zgɣ
xml	sml	Phon1	axmil	zˤbˤi
ʃɣr	mɣr	Phon1	taʃɣra	ɦsm
ɣnr	knr	Phon1	aɣnar	ʃxi
ldˤrˤ	mdˤrˤ	Phon1	taldˤrˤa	sħl
klʒ	mlʒ	Phon1	amklaʒ	ʃrɣ
rzu	lzu	Phon1	arzuz	sbi
bˤrˤu	dˤrˤu	Phon1	tibˤrˤi	zrf
gbu	ɦbu	Phon1	tigbi	ɦkn
ɣdu	rdu	Phon1	tiɣdi	ngm
nbˤl	ntˤl	Phon2	anabˤul	ʃlu
ʃkx	ʃlx	Phon2	aʃkkix	lzn
lgu	lku	Phon2	ilgan	ɣwrˤbˤ
abr	aɦr	Phon2	abbar	lkkz
dʒl	dzl	Phon2	adʒʒal	zbn
mkl	mzl	Phon2	tamkla	nzr
lʃu	lbu	Phon2	tilʃi	nzɦ
nbl	nwl	Phon2	tanbla	kʃr
ɦru	ɦsu	Phon2	tiɦri	agʒʒal
kwlʒ	kwrʒ	Phon2	takwlʒa	dbr
nʃl	ngl	Phon2	tanʃla	kħi
ʃlb	ʃlm	Phon3	aʃlab	ɣwzi

mʒn	mʒr	Phon3	amʒin	zdl
ʃmɣ	ʃmx	Phon3	taʃmɣa	zˤbˤɣ
gwnʒ	gʷnz	Phon3	agwnaʒ	flg
abˤn	abˤu	Phon3	ibˤin	azdal
srx	srn	Phon3	asrax	ʃɣn
ɣʷlˤʃ	ɣʷlˤb	Phon3	tiɣʷlˤʃi	**mlz**
arʃ	alʃ	Phon3	arraʃ	rˤdˤzˤ
gʒm	gʒl	Phon3	agʒam	aLħarˤ
fnʃ	fns	Phon3	afnaʃ	kʷls
sln	slɦ	Phon3	aslan	ɦbˤrˤ

Appendix D

Experiment 4. Real Words with Croots

Target		Root		Control	
ħfr	‘kick’	aħfur	‘hole’	ntl	‘hide’
lgr	‘lock’	talgrawt	‘locking’	xnng	
zdɣ	‘live’	amzdaɣ	‘cemetery’	lkm	‘arrive’
mgr	‘harvest’	tamgra	‘harvest(N)’	nql	‘move
zˤbˤrˤ	‘hurt’	azˤbbˤarˤ	‘stomachache’	msl	
ɣwrˤsˤ	‘slaughter’	tiɣrˤsˤi	‘slaughter (N)’	atbir	‘pigeon’
nkr	‘wake up’	tankra	‘waking up’	ɣli	‘ascend’
rˤzˤm	‘open’	arˤzzˤum	‘opening’	bdr	‘mention’
lwr	‘escape’	talwra	‘escape(N)’	mdˤlˤ	
kʃm	‘enter’	akʃʃum	‘entering’	nsr	‘blow one’s nose’
frs	‘sharp’	afras	‘radish herbs’	zlɣ	‘take’
krz	‘plow’	amkraz	‘plow (tool)’	nqr	‘remove’
lbˤʒˤ	‘crash’	albˤaʒˤ	‘crash(N)’	mtr	‘burry’
zlf	‘beat’	azlaf	‘bowl’	srs	‘put down’
ɣʷrˤdˤ	‘lie’	aɣʷrˤadˤ		kʷmz	‘scratch’
ʒdr	‘burn’	aʒdar	‘burning’	sti	‘select’
srm	‘peel’	asram	‘zest’	zdi	‘join’
mmrz	‘wound in the head’	ammraz	‘wound (N)’	nħs	‘upset’

Experiment 4. Nonwords with Croots

Target	Root	Control
ɦsl	aɦsul	mʃr
ngm	tangma	ʃlx
ʒbɣ	anʒbaɣ	rgn
ngl	tangla	knr
gʒl	agʒʒal	nʃr
ɣwlˤʃ	tiɣwlʃi	kls
mkl	tamkla	nzr
nʃl	tanʃla	dbr
nwl	tanwla	msr
ʃɣr	taʃɣra	mzl
fnʃ	afnaʃ	sɦl
lˤdˤrˤ	alttˤarˤ	ʃlm
knf	taknfa	lʒn
agbul	agabil	ʃrɣ
ʃkx	aʃkkix	ɦlʒ
klʒ	amklaʒ	ʃmx
lˤdˤʒ	aldˤaʒ	sbi
ftr	tiftirt	lkkz

Experiment 4. Real Words with Vroots

Target		**Root**		**Control**	
knu	‘bend’	tikni	‘bending’	rˁdˁu	‘accept’
zzill	‘see’	azil	‘sight’	azn	‘send’
arm	‘try’	tirmt	‘food’	ftu	‘pasture’
bdˁu	‘divide’	tibdˁit	‘division’	agʷr	‘be older’
mun	‘accompany’	asmun	‘gathering’	asi	‘carry’
ars	‘clean’	arras	‘digger’	bdu	‘start’
akʷi	‘cross’	asakʷi	‘bridge’	amggaru	‘last one to arrive’
adˁu	‘fold’	idˁi	‘act of folding’	ʃqqu	‘be difficult’
gru	‘pick’	tigri	‘pick (N)’	aʃtt	‘come’
gnu	‘sew’	tigni	‘sewing’	akʷr	‘steal’
akʷl	‘stomp’	akal	‘land’	qdˁu	‘do’
sawl	‘talk’	awal	‘talk (N)’	luħ	‘throw’
ffuɣ	‘go out’	ufuɣ	‘going out’	adˁrˁ	‘mix’
kdˁu	‘smell’	ikdˁi	‘smell (N)’	amn	‘believe’
ara	‘write’	tirra	‘writing’	ʒrˁu	‘happen’
fru	‘separate’	ifri	‘pool’	ggall	‘swear’
rar	‘give back’	iraran	‘vomit(N)’	xwu	‘empty’
adr	‘pin down’	addar	‘cowshed/pen’	rˁuʃʃˁ	‘water’

Experiment 4. Nonwords with Vroots

Target	Root	Control
abr	abbar	flu
lʃu	tilʃi	tiɦmi
lbu	aslbu	aʒrr
qbˤu	tiqbˤi	aʒʒr
sbu	tisbi	tiʃirt
abˤn	ibˤin	ɣwu
rdu	tirdi	tiʒmi
ɣdu	tiɣdi	tilˤbˤi
ʒwu	aʒuʒwu	tiʃfi
xdu	tixdi	tiʒwi
arʃ	arraʃ	dmu
lus	alsus	ibˤilˤ
bˤlˤu	tabˤlˤuʒʒi	tiɦsi
lʃu	alʃuʃ	arn
ɦru	tiɦri	tiɣwi
ɦsu	aɦsus	abl
ɣrˤu	aɣrˤurˤ	tarxsa
ʃru	tiʃri	tibˤlˤi

Appendix E

Incongruent pairs with real words primed with nonwords

aħbbˁudˁ	'belly'	REAL WORD	aʃmli	NONWORD
argaz	'man'	REAL WORD	agabil	NONWORD
asmal	'kitchen'	REAL WORD	arʃuʃ	NONWORD
anqqab	'hole'	REAL WORD	aqʷrir	NONWORD
aɣʷnʒa	'wooden spoon'	REAL WORD	aʃnar	NONWORD
amɣarˁ	'leader of people'	REAL WORD	taburi	NONWORD
asmri	'cooking'	REAL WORD	anaʒʒr	NONWORD
amazzr	'waterfall'	REAL WORD	aʒru	NONWORD
adˁarˁ	'foot'	REAL WORD	Inʒˁi	NONWORD
tandra	'moan'	REAL WORD	aktur	NONWORD
tuʃʃrka	'share'	REAL WORD	tagʷnʒa	NONWORD
arbbu	'baby sling'	REAL WORD	anzˁbˁaɣ	NONWORD
amħdˁarˁ	'student'	REAL WORD	arˁɣʷnabˁ	NONWORD
azil	'sight'	REAL WORD	amzˁalˁ	NONWORD
azˁbbˁarˁ	'stomachache'	REAL WORD	agʷzˁbˁabˁ	NONWORD
arttˁal	'loan'	REAL WORD	talka	NONWORD
tinzar	'nose'	REAL WORD	aɣʷmza	NONWORD
afrˁuɣ	'boy'	REAL WORD	aʃfuʃ	NONWORD
aħggarˁ	'arrogant'	REAL WORD	agwllan	NONWORD
tasˁdˁiħt	'terrace'	REAL WORD	abˁalˁ	NONWORD

asnus	‘colt’	REAL WORD	aʒrag	NONWORD
akrbu		REAL WORD	agrʒin	NONWORD
agnsu	‘inside’	REAL WORD	ablal	NONWORD
azˁrˁu	‘rock’	REAL WORD	akdil	NONWORD
akʃʃˁudˁ	‘wood’	REAL WORD	arzuz	NONWORD
azlag	‘small mountain’	REAL WORD	aħraʃ	NONWORD
talgrawt	‘locking’	REAL WORD	ankʃa	NONWORD
aɣjul	‘monkey’	REAL WORD	aɣalaʃ	NONWORD
agdur	‘big pan’	REAL WORD	anubbu	NONWORD
agadir	‘wall’	REAL WORD	iʃkʷfar	NONWORD
agdˁidˁ	‘bird’	REAL WORD	timʒal	NONWORD
asram	‘zest’	REAL WORD	amngal	NONWORD
atbir	‘pigeon’	REAL WORD	agmʃu	NONWORD
taħanut	‘small shop’	REAL WORD	afimgil	NONWORD
tawrˁiqt	‘paper’	REAL WORD	tiʃirt	NONWORD
taqsˁrˁijt	‘clay large plate (where couscous is served)’	REAL WORD	lˁxʷbˁlˁt	NONWORD

Incongruent pairs with nonwords primed with real words

taʃrda	NONWORD	aqʷlil	‘clay bottle’	REAL WORD
akldu	NONWORD	aqʷʒi	‘hole’	REAL WORD
afnaʃ	NONWORD	aʒdar	‘burning’	REAL WORD
anħbal	NONWORD	tirkmin	‘turnips’	REAL WORD
aʒalim	NONWORD	aruku	‘dish’	REAL WORD
aʒˤlˤu	NONWORD	tamdint	‘city’	REAL WORD
aksˤsˤubˤ	NONWORD	aslaɣ	‘sticker’	REAL WORD
tanaʒilt	NONWORD	afrig	‘border’	REAL WORD
taljart	NONWORD	ugʒan	‘vomit’	REAL WORD
anʒˤalˤ	NONWORD	tiflut	‘door’	REAL WORD
agbul	NONWORD	tifdnt	‘toe’	REAL WORD
asˤarˤin	NONWORD	ikru	‘ram’	REAL WORD
taʃmɣa	NONWORD	aħfur	‘hole’	REAL WORD
aʃglʃ	NONWORD	ignzi	‘forehead’	REAL WORD
agʒam	NONWORD	imzˤi	‘young goat’	REAL WORD
aʒˤarˤin	NONWORD	azlaf	‘bowl’	REAL WORD
anbru	NONWORD	aɣddˤarˤ	‘cheater’	REAL WORD
talˤdˤrˤa	NONWORD	tiɣrˤsˤi	'slaughter (N)’	REAL WORD
andul	NONWORD	agʷʒdˤadˤ	‘snake’	REAL WORD
iklam	NONWORD	aʃntuf	‘hair’	REAL WORD
taʃrna	NONWORD	amuddu	‘travel’	REAL WORD
alugu	NONWORD	lʒamaˤ	‘mosque’	REAL WORD
alħdij	NONWORD	taduli	‘covering’	REAL WORD

akʃal	NONWORD	taguni	‘sleep’	REAL WORD
ikltir	NONWORD	tadˁurˁi	‘fall’	REAL WORD
aɣzaj	NONWORD	asli	‘groom’	REAL WORD
amrdaz	NONWORD	aʃiʃaw	‘chicken’	REAL WORD
igmʒi	NONWORD	awttˁuf	‘moth’	REAL WORD
aʃbaw	NONWORD	aslm	‘fish’	REAL WORD
asamu	NONWORD	lmida	‘table’	REAL WORD
tawlilt	NONWORD	afulki	‘beauty’	REAL WORD
ilgan	NONWORD	tigmmi	‘house’	REAL WORD
taknfa	NONWORD	tamazirt	‘hometown’	REAL WORD
analg	NONWORD	aʒddig	‘flower’	REAL WORD
akʷlaʒ	NONWORD	tarjalt	‘bag’	REAL WORD
afisus	NONWORD	abˁukadˁ	‘blind’	REAL WORD