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The Mental Representation of Semitic Words

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This article is concerned with external evidence bearing on the nature of the units stored in the mental lexicons of speakers of Semitic languages. On the basis of aphasic metathesis errors we collected in a single case study, we suggest that roots can be accessed as independent morphological units. We review documented language games and slips of the tongue that lead to the same conclusion. We also discuss evidence for the morphemic status of templates from aphasic errors, language games, and slips of the tongue. We conclude that the available external evidence is best accounted for within a morpheme-based theory of morphology that forms words by combining roots and templates.

Keywords: roots, templates, Semitic, metathesis, morphology, aphasia

Know that the biradical root may be permut[ed] in two ways, like *qad – daq, šad – daš.* The triradical root may be permut[ed] in six ways; this is called ''six-way variation'', like *ḍaraba – ḍabara – baraḍa – baḍara – raḍaba – rabaḍa.* The quadriradical root may be permut[ed] in twenty-four ways, because each of its four radicals may be combined with the six permutations of the triradical roots, making a total of twenty-four ways.

Al-Khaliil ibn 'Aḥmad [born 718 CE, Oman, died 791, Persia], *Kitaab al-'ayn*

1 The Nature of Semitic Lexical Units

Does the mental lexicon contain fully formed words or morphemes that are concatenated by operations of affixation? In Semitic, the possibility of a morpheme-based lexicon has raised more concern than in other language families because it implies the existence of roots, that is, strings

of consonants (e.g., Arabic /ktb/, expressing the semantic field of writing). Semitic roots are abstract by virtue of the fact that they surface discontinuously, that is, separated by vowels adding morphological information (e.g., the perfective /a-a/ in *katab* 'wrote', or the passive /u-i/ in *kutib* 'was written'). Words are formed when roots are combined with a template and vocalic morphemes (e.g., *katab* 'wrote'). Some languages also have forms consisting solely of a root and a template, with epenthetic vowels, as in Moroccan Arabic *ktib* 'he wrote' and Inor Gurage *dift'* 'hit!'. On the other hand, in a word-based morphology the Semitic lexicon would not contain roots as independent morphemes. Instead, it would store vocalized words, such as /yaktub/ 'write(s)', and form related words through output-to-output mechanisms, that is, processes that take a fully formed word and turn it into another fully formed word (e.g., *yaktub* → *katab* 'wrote'). Let us note, however, that output-to-output rules can also be used by morpheme-based models, as long as the stored lexical units are morphemes, or at least words in which morphemic division is present underlyingly. As an alternative to both approaches, the lexicon could simply store all surface forms and express lexical relatedness through lexical correspondence rules.

Bohas and Guillaume's (1984) and Goldenberg's (1994) surveys of the notion of root in Semitic show that this debate has opposed linguistic schools of thought for centuries. Glossing over distinctions between verbal and nominal morphologies, we may distinguish two views. On the one hand, Arabic and Hebrew grammarians viewed Semitic roots as paradigmatic relations existing between fully formed words, rather than as autonomous morphemes. This view was later echoed in Saussure's (1978) associative series. Recent studies that likewise deny roots an autonomous lexical status include Mahadin 1982, Heath 1987, Bat-El 1994, Ratcliffe 1997, and Ussishkin 1999. This view implicitly or explicitly favors a word-based theory of morphology. On the other hand, structuralists such as Cantineau (1950) and Harris (1951) recognized roots as autonomous morphemes expressing the basic meaning of the word, additional morphological information being expressed by a distinct vocalized pattern. The latter view is echoed in autosegmental analyses such as those of McCarthy (1981) and Hoberman (1988), which typically further separate vocalized patterns into morphemes consisting of vowels only (such as /a-a/ and /u-i/) or templates only (to distinguish between *kutib* 'was written' and *kuttib* 'was caused to write'). Such analyses implicitly or explicitly adopt a morpheme-based theory of morphology since their lexicon includes roots such as /ktb/.

In this article, we will use evidence from aphasic metathesis errors we collected in a single case study to suggest that Arabic roots can be accessed as independent morphological units. The most likely formal interpretation of this access is that the Arabic lexicon contains roots. To show that these errors are not specific to aphasic speech, we will also review external evidence based on ludlings (i.e., language games) and slips of the tongue. We will also discuss external evidence for templates since Semitic word formation involves templates in all root-based and most word-based theories. Finally, we will show that metatheses are pervasive in several areas of Semitic, and we will propose a formal explanation of the ease with which root consonants can be reordered.

2 External Evidence for Roots

The crux of our evidence comes from a case study of a bilingual Arabic-French aphasic patient. We will also discuss evidence from language games and slips of the tongue. In all three instances,

we will show that Arabic stem consonants are prone to undergo metathesis. This specificity, we will argue, is better captured in models that hold that Arabic (and Semitic) underlying representations (URs) are different from those of other languages.

2.1 Metatheses in Aphasic Speech

2.1.1 Language Assessment   ZT is an early Arabic-French bilingual. A native speaker of Lebanese Arabic, he started studying Standard Arabic and French at school in Lebanon at the age of 4. He attended a bilingual school where sciences were taught in French and other subjects in Arabic. At the age of 22, he moved to Montreal, Canada, and attended a French-speaking university. He graduated as an engineer, then worked for eight years in companies where French was the main language used. ZT still spoke Arabic at home and with friends. At the age of 32, he suffered a stroke that resulted in a severe mixed aphasia, that is, a language deficit in which oral production and comprehension were impaired in both Arabic and French.

ZT was tested in Arabic and French by native speakers of the two languages at the same time post-onset.[1] Testing was conducted one language at a time. ZT's output was immediately recorded and transcribed. Among the tasks that ZT was required to perform were reading aloud, repetition, oral and written picture naming, and writing to dictation.[2]

One year after the stroke, language assessments of ZT's Arabic and French showed mildly impaired oral comprehension of long and complex sentences. He did not, however, have difficulties understanding isolated words, which was the object of our testing. Oral production was found to be severely impaired, with the exception of word repetition. Writing and reading were severely impaired in both languages.

ZT's language impairment in both Arabic and French showed the characteristics of deep dyslexia.[3] ZT produces reading errors that are typically found in deep dyslexic patients: semantic errors (e.g., Arabic *ʔafyuun* 'opium' → *siigaaṛa* 'cigarette', French *royal* 'royal' [rwayal] → *prince* [prɛ̃s] 'prince'), visual and/or semantic errors[4] (e.g., Arabic نِضَال *niḍaal* 'struggle, battle' → بَطَل *baṭal* 'hero', French *numéro* [nʊmero] 'number' → *zéro* [zero] 'zero'), morphological errors (e.g., Arabic *ʔa-zhaaṛ* 'flowers' → *zahṛ-a,* 'flower', French *goûter* [gute] 'to taste' → *goût*

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[1] We tried to control for dialectal variation in Arabic. Hence, ZT's deviations from Standard Arabic (SA) caused by interference from his Lebanese Arabic (LA) dialect were not regarded as errors (e.g., SA *riẑl* 'leg, foot' → LA *ʔiẑir*).

[2] In the reading aloud task, ZT was asked to read aloud fairly frequent isolated word stimuli. The error pattern in reading is similar in both the shallow (with diacritics) and the deep (without diacritics) Arabic writing system. This confirms that his reading impairment results from an output rather than an input deficit. The repetition task involved repeating a set of words after hearing them pronounced. In the picture-naming task, ZT was shown a picture and was asked to name its content either orally or in writing. In the writing-to-dictation task, words were read aloud and ZT was asked to write them down.

[3] Dyslexia is called ''deep'' when the acquired reading disorder is characterized by the production of semantic errors (e.g., *tobacco* read as *cigarette*). Deep dyslexia contrasts with surface dyslexia, a syndrome that involves the inability to read irregular words such as *yacht*. In the deep form of dyslexia, reading errors occur at a ''deeper'' semantic level, whereas in surface dyslexia, they arise from a surface-level impairment in decoding the written input. Thus, the word *knife* may be read as *fork* by a deep dyslexic but as [knaɪf] by a surface dyslexic.

[4] These errors are defined as visual and/or semantic because there is both a visual and a semantic resemblance between the target and the error.

[gu] 'taste'), and phonemic errors (e.g., Arabic *ʔa-ẓfaan* 'eyelids' → *ʔa-šbaan,* French *tâcher* [tɑše] 'to endeavor' → [tɑšo]).

Because ZT produces semantic errors not only in reading aloud but also in picture naming, his language impairment corresponds to the ''output form'' of deep dyslexia. ZT produces semantic errors in Arabic and French in both oral reading and oral picture naming, not because of a disorder in accessing the semantic system (input form of deep dyslexia) or one affecting the semantic system itself (central form of deep dyslexia) but because he has difficulties accessing the phonological form of the word from an unimpaired semantic system (output form of deep dyslexia). ZT makes exactly the same types of errors in both languages but, we will show, he also makes metathesis errors much more frequently in Arabic than in French.

Full assessments of ZT's language performance by Mimouni et al. (1995) and Béland et al. (2000) revealed that he displays 9 of the 12 features of the deep dyslexia syndrome in both languages (see Plaut and Shallice 1993). These features refer to the error pattern (semantic, visual, morphological errors) and to the type of stimuli that are more sensitive to reading errors (function words, verbs, abstract words, nonwords).[5] His pathology is absolutely parallel for all criteria in both languages.

2.1.2 Arabic and French Metatheses   Among the errors that characterize ZT's performance in Arabic are frequent metathesis errors, which consist of modifying the linear order of root consonants. ZT produced these errors in all four tasks (reading aloud: 39/119 = 32.8%; repetition: 38/ 119 = 31.9%; writing to dictation: 17/119 = 14.3%; picture naming: 25/119 = 21%, for a total of 119 errors). In the course of this article, we will provide the whole corpus of metathesis errors in Arabic (and French) in the body of the text and tables. For convenience, the 119 Arabic metathesis errors are also listed in the appendix, sorted by roots in alphabetical order.

The examples in (1) illustrate two instances of consonant metathesis in each task. We will not indicate in the rest of the article the task from which the error was drawn. However, when produced in the writing-to-dictation task, the error will be quoted phonetically without short vowels to reflect ZT's Arabic transcription. The suffix *-t* is the orthographic representation of the feminine phonetic suffix *-a.* Our interpretation of the word and gloss intended by ZT will be indicated as 'possibly X'.

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[5] ZT also displays four additional features specific to the output form of deep dyslexia. In both languages, (a) word repetition is almost unimpaired but nonword repetition is severely impaired, (b) oral picture naming is impaired, (c) lexical decision in visual and auditory input modalities is unimpaired (the lexical decision task requires the patient to answer YES or NO when asked if a stimulus presented auditorily or visually is a word; usually, half of the stimuli, presented randomly, are words and half are nonwords), and (d) implicit (i.e., ''unconscious'') access to the phonology of nonwords from visual print is preserved. In ZT's case, a significant cross-script homophone priming effect was obtained in a lexical decision task; that is, his reaction times are shorter in trials in which Arabic word stimuli are preceded by a homophonous French nonword prime than by a nonhomophonous prime. Note that the term *output* is used in psycholinguistics as synonymous with *production.* It means that the patient has problems producing but not understanding. It does not refer to the output of a derivation in formal linguistics.

(1) Examples of consonant metathesis in Arabic

Target	Output	Target gloss	Task
ʕušb	šuʕb	'grass'	reading aloud
fašil	šafɨl	'failed'	reading aloud
ma-žhuud	ma-žduuh	'effort'	repetition
faašil	šaafil	'failing'	repetition
baħṛ	ħbr (حبر)	'sea'	writing to dictation
mi-nṭaq-a	m-ṭnq-t (منطقة)	'region'	writing to dictation
naxl	xanl	'palm trees'	picture naming (written)
ṣaħaaʔif	ṣafaaʔiħ	'newspapers'	picture naming (oral)

Two further aspects of ZT's metatheses are noteworthy. First, even if the linear order of consonants is affected, patterns and vowels usually remain intact in all tasks. The examples in (2) illustrate this point. The last two examples also involve phonemic or mapping errors, in addition to metathesis.

(2) Examples showing that patterns and vowels are unaffected

Target	Output	Target gloss
ʔi-bṛiiq	ʔi-qbiiṛ	'coffeepot'
fanaažiin	fažaaniin	'cups'
fuħuuṣ	fuṣuuħ	'examinations, scrutinies'
ħaṣṣaad	ṣaħħaad	'harvester'
ħubul	ħulub	'ropes'
kuʔuus	kusuuʔ	'glasses'
laymuun	malyuun	'lemon'
mu-xriž	mu-xžir	'producer'
ma-nṣuub	ma-ṣnuub	'set'
ma-naazil	ma-laazin	'houses'
qubṭaan	quṭbaan	'captain'
šayaaṭiin	šaṭaayiin	'satans'
ta-faħħuṣ	ta-ħaffuṣ	'scrutiny'
ṭarbuuš	ṭašbuur	'hat'
xanaaziir	xazaaniir	'pigs'
zirr	ṛizz	'button'[6]
ʕaqaaṛib	ʕanaaqib	'scorpions'
zaṛṛ-aat	zazṛ-aat	'buttons'

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[6] The word for 'rice' (ṛizz) is wholly emphatic whereas the word for 'button' (zirr) contains no emphasis.

An overview of ZT's metatheses reveals that they all involve consonants only. The linear order of the vowel melody elements is never affected. In addition, ZT's metatheses target the consonants of the root only. Affixal consonants (in prefixes, suffixes, and infixes) are never involved, as shown in (3).[7]

(3)   Examples showing that affixal consonants are not involved

Target	Output	Target gloss
ʔiħ-t-imaal	ʔiħ-t-ilaam	'probability'
fuqaṛ-aaʔ	fuṛaq-aaʔ	'poor people'
lawħ-a	walħ-a	'picture, painting'
ma-ʔaaðin	ma-daaʔin	'minarets'
ma-hṛaž-aan	ma-ṛhaž-aan	'festival'
ma-laaʕiq	ma-ʕaaliq	'spoons'
ma-ṛkaz	m-krz (possibly *ma-kraz*)	'center'
ma-sbaħ	ma-ħbas	'swimming pool'
ma-žall-a	m-lž-t (possibly *ma-lažž-a*)	'magazine'
ma-žlis	m-lžs (possibly *ma-lžis*)	'council, sitting room'
mi-ʕṭaf	mi-ṭʕaf	'coat'
mi-ṣmaar	m-mṣaar (possibly *mi-mṣaar*)	'nail'
mu-ṣħaf	m-ṣfħ (possibly *mu-ṣfaħ*)	'Holy Book'
ʔis-t-aʕṭaf	ʔis-t-aʕfaṭ	'begged'
ʔis-t-adṛaž	ʔis-t-ažṛad	'led progressively'
ʔis-t-iʔnaaf	ʔis-t-ifnaaʔ	'appeal'
ṣafħ-a	ṣħf-t (possibly *ṣaħf-a*)	'page'
ṣaħaaf-a	ṣfaah-t (possibly *ṣafaaħ-a*)	'media'
ta-faħħaṣ	t-ṣfr (possibly *ta-ṣaffar*)	'examined'[8]
ta-laaħum	ta-laamuħ	'solidarity'
tilifuun	tfluun (possibly *tifiluun*)	'telephone'
ta-waqquf	ta-qawwuf	'stopping'

Proximity to the edge of the word has no effect on access to the root. Regardless of the number of prefixes or suffixes, the consonantal root is the exclusive domain of metathesis, as shown in (4). The last example also displays a phonemic error.

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[7] Only one exception was recorded (in the repetition task): *ta-kaatub* 'corresponding with each other' → *ka-ta-atub*. One similar error was also made in French (in the writing-to-dictation task): *démuni* (/de-müni/) 'impoverished' → *medunis* (see section 2.1.2).

[8] We analyze this error as involving substitution of a root consonant rather than replacement of the whole root because (a) two of the three target root consonants remain unchanged, and (b) ħ and r are close phonologically (both are sonorants and, when occurring together, they usually trigger emphasis, as in *ħibṛ* 'ink').

(4) Proximity to the edge of the word does not affect root consonant methathesis

Target	Output	Target gloss
ʔa-ðrif-a	ʔa-fðir-a	'envelopes'
ʔa-rnab-aat	ʔa-nrab-aat	'rabbits'
ʕarž-aaʔ	ʕažr-aaʔ	'lame (FEM)'
faṛaaš-aat	fašaaṛ-aat	'butterflies'
ma-ʕaadin	ma-daaʕin	'minerals'
ma-ʕbad	ma-ʕdab	'temple'
ma-fṛas-a	ma-ṛfas-a	'stable'
ma-lħam-a	ma-ħlam-a	'butcher's shop'
mi-ṭraq-a	mi-qṭar-a	'hammer'
mu-s-t-aʕmiṛ	mu-s-t-amʕiṛ	'colonizer'
ʔis-t-aʕṭaf-naa	ʔis-t-afṭaʕ-naa	'we begged'
ʔis-t-ihdaaf	ʔis-t-ifdaah	'targeting'
ʔis-t-iṛaaħ-a	ʔis-t-iħaaṛ-a	'pause'
ya-ɣṛaq-uun	na-ṛqaʕ-uun	'they drown'

ZT's metatheses affect root consonants in verbs, nouns, and adjectives but, as we have just shown, they do not affect affixal consonants and vowels.[9] In standard autosegmental representations, the root consonants and the vocalic morphemes are represented on separate tiers dominating a prosodic template, as are all affixes, including infixes such as -t- in f-t-axaṛ 'boasted'. ZT's errors are compatible with autosegmental representations if we assume that only the root tier is subject to metathesis. As Arabic roots contain only consonants, it follows that only nonaffixal consonants will be affected by metatheses operating on the root tier.[10]

ZT produced only 12 metatheses in French, as shown in (5).

(5) All metathesis errors in French

Target			Output	Target gloss	Task
a. naval	[naval]	→	[vanal]	'naval'	reading aloud
vanille	[vanij]	→	[valin]	'vanilla'	reading aloud
éclipser	[eklipse]	→	[eplikse]	'to eclipse'	repetition
démuni	[demʉni]	→	medunis	'impoverished'	writing to dictation
b. ballerine	[balrin]	→	[parlin]	'ballerina'	repetition
c. plient	[pli]	→	[pile]	'they fold'	reading aloud

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[9] Although many stimuli contained infixes, ZT made only one error on an infixed word, in which the infix was not affected: ʔiħ-t-imaal 'probability' and ʔiħ-t-ilaam 'dreaming, having a wet dream'.

[10] Even radical glides that do not surface in some patterns (e.g., w in /mawat/ → maat 'died') should be able to undergo root consonant reversal since we view metathesis as affecting the root tier. We have no data from ZT bearing on this prediction, but we interpret the near-synonymous root doublets bwx/bxw, ħwq/qwħ, ħkw/kwħ, ṭwʕ/ʕṭw, ʕwq/wʕq in (28) as evidence that it is borne out in the realm of diachrony.

d.	pédalo	[pedalo]	→	palodé	'pedal boat'	writing to dictation
	estomac	[ɛstɔma]	→	escamot	'stomach'	writing to dictation
e.	darin	[darɛ̃]	→	[dãri]	nonword	reading aloud
	agenda	[aʒɛ̃da]	→	angeda	'agenda'	writing to dictation
f.	feuille	[fœj]	→	fueille	'leaf'	writing to dictation
	goûter	[gute]	→	guote	'to taste'	writing to dictation

We count all of these errors as metatheses but it is clear that only the five errors in (5a–b) are truly comparable to the Arabic ones. They involve metatheses between nonadjacent (5a) and adjacent (5b) consonants. The error in (5c) metathesizes a consonant and a vowel (*l* and *i*), whereas the ones in (5d) involve multiple reversals of consonants, vowels, or syllables, including that of the silent consonant ⟨c⟩ in *estomac*. The two errors in (5e) involve movement of a nasal rather than metathesis *stricto sensu*. Finally, the two errors in (5f) are limited to vowels (*goûter* [gute] → *guote* 'to taste' and *feuille* [fœj] → *fueille* 'leaf'). In fact, they were both produced in writing and both involved the reversal of digraphs, *ou* → *uo* and *eu* → *ue,* which actually left the target's phoneme order intact.

In addition to these qualitative differences, we observe a significant quantitative difference: the Arabic metatheses are much more numerous than the French ones (119 in Arabic and 12 in French) although the total number of stimuli used in testing ZT was almost the same: 1455 in Arabic and 1498 in French. There is a striking difference between the rates of metatheses in Arabic (119/1455 = 8.18%) and French (12/1498 = .80%). And if we only include truly comparable errors, for French we must retain only the five errors in (5a–b), which brings the error rates to 8.18% (Arabic) versus .33% (French), that is, a proportion of 25 to 1. The difference in the proportion of metathesis errors in the two languages is highly significant ($\chi^2 = 111, p < .0001$).

2.1.3 A Morphological Explanation   Let us consider possible explanations for the quantitative discrepancy between the two languages. We will argue that phonetic and graphemic rationales are unsatisfactory. As the impairment is the same in both languages, the differences must stem from the fact that the morphological units involved are different in Arabic and French.

Consider a phonetic account first. It cannot be claimed that ZT has phonetic problems with Arabic consonants because of perceptual or articulatory difficulties. Béland et al. (2000) have shown that he has no problems discriminating minimal pairs in both languages. Phonetics is clearly not involved because even the consonants common to both languages, that is, /t, k, b, d, f, s, z, š, ž, m, n, r, l, w, y/, are metathesized in Arabic only. Furthermore, phonetics cannot explain why ZT targets radical consonants but not affixal ones in Arabic.

One might also argue that ZT's metatheses single out Arabic consonants because this language is written with consonant symbols only. Arabic short vowels are indicated by means of diacritics below or above letters but only under particular conditions (e.g., in the Quran and in schoolbooks intended for children or second language learners). Usually, only consonants and long vowels are written down. Thus, the salience of consonants in Arabic words could be taken to follow from their orthographic transcription. This explanation cannot be maintained, though, for four reasons.

First, the graphemic explanation is invalid because ZT does not displace consonantal prefixes and suffixes even though they are also transcribed. Not only does he not move affixal consonants around but he does not even do this when they are homophonous with root consonants. The consonant of the prefix *ma-*, for instance, could be mistaken for a root consonant. In Arabic, roots abound whose first root element is *m* (e.g., *malaak* 'angel', *miskiin* 'poor', *maydaan* 'field', *miinaaʔ* 'harbor'). Yet ZT spares prefixes even when they consist of consonants that could be radical, as shown in (6).

(6) Distinction between radical and affixal homophonous consonants

Target	Output	Target gloss
a. m̲asaħ	sam̲aħ	'wiped'
m̲asaaʔ	sm̲aaʔ (possibly *sam̲aaʔ*)	'evening'
b. m̲a-žall-a	m̲-lžt (possibly *ma-lažž-a*)	'magazine'
m̲u-xriž	m̲u-xžir	'producer'

When *m* is part of the root (6a), it can be metathesized, but when it belongs to a prefix (6b), it remains in situ. It is clear, then, that ZT runs a morphological scan to separate roots and affixes. He does not rely on spelling, since spelling does not separate stems and affixes in Arabic.

Is it possible, then, that ZT does not consider the graphemes of the whole word but only those of the window enclosing the vocalized stem? This cannot be the case either, because he metathesizes graphemes corresponding to consonants but not those corresponding to long vowels. As just mentioned, long vowels are always represented in Arabic script. As shown in (7), the symbols for /w/ ⟨ ⟩, /y/ ⟨ ⟩, and /ʔ/ ⟨ ⟩ indicate length in *uu, ii,* and *aa,* respectively. (Recall that Arabic is written from right to left.)

(7) qur⟦uu⟧d   قرود   'monkeys'

kab⟦ii⟧r   كبير   'big, large'

ðub⟦aa⟧b   ذباب   'flies'

Although long vowels are transcribed in the Arabic script, ZT does not metathesize them (e.g., *ma-žhuud* 'effort' → *ma-žduuh, xanaaziir* 'pigs' → *xazaaniir*). If he considered only the graphemes of the stem, he would move those of the long vowels along with those of the stem consonants.

Third, when ZT produces written metatheses, he respects the distribution of the allographs. Several Arabic letters adopt different shapes depending on their position in the letter string (e.g., *y* is written ⟨ ⟩ word-initially, ⟨ ⟩ word-medially, and ⟨ ⟩ word-finally). In writing *ħbr* (possibly *ħibr* حبر 'ink') for *baħr* بحر 'sea' or *hdf* (possibly *hadaf* هدف 'goal') for *fahd* فهد 'leopard', for instance, ZT spontaneously used the appropriate allographs. He does not move the symbols

of the written form around, which shows that he does not manipulate the graphemic representation. If he did, he would not modify the shape of the letter to respect the writing conventions of the language. He would write *hdf* as ﺑﻠﺪ instead of ﻫﺪﻑ.

Finally, ZT's language impairments are not limited to tasks involving written input or output modalities. He also produces errors in spontaneous speech, oral picture naming, and repetition of nonwords, all tasks that do not involve mandatory written material. Hence, the problem cannot be due to the orthographic peculiarities of Arabic.

In the remainder of this article, we will show that ZT's consonant metatheses are identical to changes observed throughout Semitic in ludlings, slips of the tongue, and diachronic changes. Some of these Semitic languages transcribe all vowels (Classical Ethiopic, Amharic) or do not have a written tradition (most dialects of Arabic, all dialects of Gurage). This confirms our conclusion that orthography plays no role in root consonant metatheses.

The discrepancy in the error rate of metatheses between ZT's two languages could also be taken to result from an impaired morphological processing selectively affecting the Arabic grammar. This hypothesis is also ruled out because the distribution of his morphological errors is similar in his two languages. In Arabic, ZT was presented verb and adjective stimulus sets in an oral reading task to assess his ability to process derivational and inflectional morphological markers. In Arabic, he produced a total error rate of 98/120 = 82%. In French, ZT was presented three stimulus sets in oral reading to test his ability to process derivational affixes and inflectional suffixes. The overall error rate in processing French affixed forms was 69/83 = 83%. The two rates are almost identical and there is no significant difference between the error proportions in the two languages (χ^2 = .007, $p > .05$).

Moreover, a qualitative analysis of ZT's morphological errors indicates that ZT is well aware of morphological boundaries in both languages because he always distinguishes homophonous syllables according to affixal or stem status. For instance, when reading *insoumis* [ɛ̃sumi] 'rebellious', ZT read *soumis* [sumi] 'obedient'. When shown the word *sondage* 'poll', which contains two morphemes, he read *sonder, radio* 'to poll, radio', which shows that he correctly analyzed it as *sond-age*. He did not mistake the letter sequence *in* in *insecte* [ɛ̃sɛkt] 'insect' for a prefix. Instead of producing *secte* [sɛkt] 'sect', he made a semantic error and read the word as [mustik] 'mosquito'. When shown the word *enquêter* 'to investigate', which contains the base *enquête* 'inquiry', he read it as *police* 'police', showing that he did not mistake it for a derivation of the verb *quêter* 'to collect'. Other examples are given in (8) for French and (9) for Arabic.

(8) Morphological errors in French

Target		Target gloss		Output	Output gloss
feuillage	[fœj-až]	'foliage'	→	[fœj]	'leaf, leaves'
refaire	[rə-fɛr]	'redo'	→	[rə-fɛt]	'redone (FEM)'
recompter	[rə-kɔ̃t-e]	'recount'	→	[kɔ̃t-e]	'to count'
tournent	[turn]	'they turn'	→	[turn-e]	'to turn'
portillon	[pɔrt-ijɔ̃]	'gate'	→	[pɔrt]	'door'

(9) Morphological errors in Arabic

Target	Target gloss		Output	Output gloss
ʔa-zhaaṛ	'roses'	→	zahṛ	'rose (GENERIC)'
xaal-a	'maternal aunt'	→	xaal	'maternal uncle'
žamiil-a	'beautiful (FEM)'	→	žamiil	'beautiful (MASC)'
ma-ktab	'desk, office'	→	kitaab	'book'
ma-qbaṛ-a	'graveyard'	→	qabṛ	'grave'
r-t-afaʕ	'rose (VERB)'	→	rafaʕ	'raised (VERB)'
ħ-t-afal	'celebrated (VERB)'	→	ħafl-a	'party'

Examples of this type abound for prefixes and suffixes in Arabic and French. Because ZT's processing of inflectional and derivational affixes is impaired in both languages, the disparity in the error rate of metatheses between his two languages cannot be caused by an impaired processing of affixed forms that would be specific to his Arabic mental grammar. It must follow from some deeper impairment that is common to both languages but is manifested only in Arabic.

We submit that ZT's errors single out Arabic consonants because they form a unit in his mental lexicon. That unit is not phonetic/phonological, since he leaves affixal consonants in place. In accessing radical consonants, ZT also identifies affixes, as evidenced by the data in (9). However, what he separates the affixes from cannot be a vocalized stem since he manipulates only the *consonants* of the stem, something he does not do in French. The set of consonants that he does metathesize in Arabic coincides with the morphological unit traditionally known as the root. He makes significantly fewer errors of this type in French than in Arabic because these two languages have different morphological representations: stem consonants do not form distinct morphemes in Indo-European languages, which makes these changes less natural (though not impossible). In section 4, we will elaborate on the consequences of this morphological explanation and rule out phonological explanations based on phonotactic and syllabic constraints.

2.1.4 Lack of Phonological and Semantic Motivation   As a typical output deep dyslexic, ZT has problems with speech production and more specifically with phonological planning, but he has no semantic disorder. It is clear that his metatheses are output errors. If ZT's competence were affected, that is, if he had lost all information pertaining to the order of root consonants, he would misunderstand words containing identical root consonants in different orders, such as the verbs *katab* 'wrote' and *kabat* 'repressed'. However, he makes no such confusions at the input processing level, that is, comprehension. Moreover, although his metatheses are frequent, they still form a small percentage of his production: most of his words show appropriately ordered consonants. Both characteristics are incompatible with actual loss of underlying order in his root entries.

The lexical entries of roots contain information of a syntactic, semantic, morphological, and phonological nature. The last is divided between segmental features, which encode place and manner makeup, and ordering information, which encodes precedence relations. ZT has problems with precedence relations. We suggest that his root entries are ordered correctly in UR but he

has difficulties either mapping root consonants to the template or keeping them in the proper order during speech production.

As far as can be determined from our limited database, ZT's metatheses are not predictable from phonological properties (such as manner or place features, sonority, or perceptibility of the type invoked by Hume (1998b) for normal metatheses) or morphological ones (such as verb classes or lexical categories). All consonants can be moved, sometimes with two or even three wrong outputs for the same root, as shown in (10).

(10) Examples showing that the same input can have several outputs

Root	Target	Output 1	Output 2	Output 3	Target gloss
ð̣rf	ʔa-ð̣rif-a	ʔa-fð̣ir-a	ʔa-ð̣fir-a		'envelopes'
sqf	ʔu-squf	ʔu-fqus	ʔu-qsuf		'bishop'
zhr	zahr̩	hzr (possibly *hazr*)			'rose'
	ʔa-zhaar̩		ʔa-zr̩aah		'roses'
b(w)xr	baaxir̩-a	baarix-a			'ship'
	bawaaxir̩	bar̩aaxiw	baxaar̩ib	baxaawir̩	'ships'
bɣḍ	buɣḍ	ɣaḍab	buḍɣ		'hatred'[11]
ʕṭf	mu-s-t-aʕṭif	mu-s-t-aʕfiṭ			'begging (ADJ)'
	ʔis-t-iʕṭaaf		ʔis-t-ifṭaaʕ		'begging (NOUN)'
	ʔis-t-aʕṭaf-naa	ʔis-t-aʕfaṭ	ʔis-t-afṭaʕ-naa		'we begged'

These examples indicate that any reordering of root consonants seems possible. Reordering could conceivably be governed by phonological or perceptual factors, but a larger body of data would be needed to identify them. However, even if such factors were at work, they would not affect our argument in favor of the lexical status of the root. As long as the root constitutes the exclusive domain of consonant reversals, it must be treated as an independent morphological unit.

It is also crucial to test if ZT's metatheses are predictable on semantic grounds because, as mentioned in section 2.1.1, lexical confusion within semantic fields is the hallmark of output deep dyslexia, such as uttering *fork* when shown the word *knife* (or when shown a knife). Consequently, it is conceivable that ZT would metathesize consonants not because of a phonological problem but because he is pronouncing a semantically related word that happens to contain the same consonants ordered differently. As we will show in section 4.1, Arabic has a number of such synonymous roots whereas French does not. However, as we will show here, ZT's errors are actually not prompted by semantic confusion.

From the point of view of meaning, ZT's errors can be divided into three categories. First are those outputs that happen to be existing words, as in (11). The last two examples also exhibit a phonemic error.

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[11] Output 1 of this word also involves a template misselection.

(11) Metatheses in which outputs are existing words

Target	Target gloss	Output	Output gloss
daxal	'entered'	xadal	'became numb'
ðarf	'envelope, situation'	ðafr	'victory'
faħaṣ	'examined, scrutinized'	faṣaħ	'was fluent'
ma-dxal	'entrance'	xadal	'became numb'
nabat	'grew'	bint	'daughter'
qird	'monkey'	qidr	'cooking pot'
ta-zalzal	'shook (of earth)'	ta-lazlaz	'was tired, shaken'
ṣafħ	'forgiveness'	ṣħb (possibly ṣaħb)	'friends'
qaws	'arch'	swṭ (possibly sawṭ)	'stripe, whip'[12]

Examination of all of ZT's errors reveals no semantic association between target and output. In some cases (e.g., *ta-zalzal → ta-lazlaz*), the output is a rare word, so we suspect that it is only by chance that the output happens to coincide with a real word.

The second category of errors comprises outputs that are nonwords but whose consonants form an existing root, as in (12). Again, there is no semantic relationship between the target and the output root.

(12) Metatheses in which outputs contain an existing root

Target	Gloss	Output	Existing word	Gloss
ʔa-saatið-a	'teachers'	ʔa-saadis-a	sudus	'one-sixth'
ʔa-wqaaf	'religious properties'	ʔa-wfaaq	wifaaq	'agreement'
faʔṛ	'rat'	faṛʔ	firaaʔ	'fur'
faṛas	'mare'	fasaṛ	fassar	'explained'
fuṣħ-aa	'standard speech'	ṣufħ-a	ṣafħ-a	'page'
ma-sžid	'mosque'	ma-ždis	žaadis	'hard'
ma-tžaṛ	'store'	ma-žtaṛ	žatr	'tent'
mi-lʕaq-a	'spoon'	mi-ʕlaq-a	ʕaaliq	'hanging'
nidaaʔ	'call'	dinaaʔ	duny-aa	'earthly life'
nuṭq	'pronunciation'	nuqṭ	nuqṭ-a	'drop (water), dot'
quruud	'monkeys'	quduur	qadar	'destiny'
ʔis-t-aʔnaf-naa	'we appealed'	ʔis-t-afneʔ	fanaaʔ	'end'

[12] On many occasions, ZT substitutes the emphatic *ṭ* for the uvular *q,* which is why we interpret this example as a metathesis of *q* and *s.* We have also observed this substitution in Moroccan Arabic child language (e.g., *suq → suṭ* 'market'). It is also reported in allophonic changes in Zway Gurage (Ethiopic), for example, *ak'nabə* versus *t'ambe bala* 'to listen', and in Qabenna (Cushitic), for example, *k'amájjo* versus *t'əmájjoʔ* 'to put the yoke' (Leslau 1992:600). Ethiopic and Cushitic emphatics are glottalized, unlike the pharyngealized emphatics of Arabic, but the two sets are cognate.

saqf	'roof'	faqs	faqas	'died, hatched'
saxaaʔ	'generosity'	xasa	xasaʔ	'chased away'
tibɣ	'tobacco'	tiɣib	taɣib	'perished'
wažas	'was afraid'	žawas	žaas	'peered, pried'
žinħ	'wing'	žiħn	žaħan	'fed (TRANS) poorly'
zaṛaaf-a	'giraffe'	zafaaṛ-a	zafṛ-a	'sigh'
zaṛaaf-a	'giraffe'	zfraa-t (possibly *zafṛaa-t*)	zafṛ-a	'sigh'
hamq-aaʔ	'crazy (FEM)'	ħaqm-a	ħaqm	'kind of pigeon'
ʔa-žfaan	'eyelids'	ʔa-šbaan[13]	šaban	'was fat'

In psycholinguistics, the errors in (11) and (12) are said to be *lexically biased* because one cannot rule out that they are prompted by phonological similarities, that is, analogy, between the target and the output forms.

The third category comprises lexically unbiased errors: these form neither words nor roots in Arabic, as in (13). Semantic motivation is out of the question for these outputs since they have no meaning. The last example also exhibits a phonemic error.

(13) Metatheses in which outputs are nonwords and nonroots

Target	Gloss	Output
ʔiθyuubyaa	'Ethiopia'	ʔabyuuθyaa
baʕθaṛ	'scattered'	baʕṛaθ
baaɣiḍ	'hating'	baaḍiɣ
biiḍ	'eggs'	ḍiib
ṛuʔas-aaʔ	'presidents'	ṛusaʔ-aaʔ
daṛṛaаž-a	'bicycle'	dažṛaаž-a

We conclude that ZT's metatheses are not caused by confusion between lexical entries that are semantically related. They are due either to an inability to consistently maintain the underlying order of root consonants during phonological derivation and speech production or, for lexically biased errors, to confusion between roots whose segmental makeups happen to be similar. We address the issue of lexical bias in section 4.1.

2.2 Metathesis in Ludlings

ZT's errors have no parallel in normal phonological processes. To begin with, productive metatheses of nonadjacent consonants are very rare. We know of three instances: the Akkadian infix *-t-*

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[13] This error seems to involve a metathesis of the feature [voice] between *ž* and *f,* with *z → š* and *f → v → b* because Arabic has no /v/.

(/ṣbt/ → *ṣi-t-butum* → *tiṣbutum* 'to seize one another'; McCarthy 1981:381), some CVCV sequences in Turkana (*ŋa-kὲmɛ̀r-a* → *ŋa-kὲrɛ̀m-a* 'mole'; Dimmendaal 1983:48), and the Mutsun suffix *-mak* (/rukka-mak/ → *rukka-kma* 'house'; Hume 1998a:170). But even if these metatheses were more frequent, ZT's errors would still be unparalleled in normal phonological processes because they involve random reversal of tautomorphemic consonants over intervening consonants. Changes of this type are attested only in occasional diachronic changes.[14] We will show in section 4.1 that such phenomena are in fact common in Semitic, but only on an unproductive and diachronic basis. On a productive basis, such phenomena exist only in ludlings, that is, language games, and slips of the tongue. Indeed, ZT's errors are identical to ludlings that exist only in Semitic.

Bagemihl's (1988, 1989) survey of ludlings shows that reversal processes of all kinds, including even mirror-image reversals, are very common except for one type: permutation. This reversal process, in which many or all of the possible root consonant reorderings are attested, has been reported for ludlings in two languages: Bedouin Hijazi Arabic and Moroccan Arabic. Examples from the former (Al-Mozainy 1981:86, McCarthy 1982:197) and the latter (Heath 1987:184) ludlings are given in (14) and (15), respectively. In (14), all five possible reorderings of the three root consonants are attested: 123 → {321, 213, 231, 312, 132}. Following Berg and Abd-El-Jawad's (1996) terminology, we call orderings in which two consonants are displaced (i.e., 321, 213, and 132) *bipartite* and orderings in which three consonants are displaced (i.e., 231 and 312) *tripartite*. The same distinction will be applied to ZT's errors in section 4. In (15), 4 of the 23 possible reorderings of four consonants are reported: 1234 → {2413, 3142, 4123, 4321, 1324, 1243, etc.}.

(14) Ludlings involving root consonant reorderings in Bedouin Hijazi Arabic

Regular form		Regular form		Regular form	
kattab	123	s-t-aslam	123	ž-t-imaʕ	123
'caused to write'		'surrendered'		'met'	
Game forms					
battak	321	s-t-amlas	321	ʕ-t-imaž	321
takkab	213	s-t-alsam	213	m-t-ižaʕ	213
tabbak	231	s-t-almas	231	m-t-aʕaž[15]	231
bakkat	312	s-t-amsal	312	ʕ-t-ižam	312
kabbat	132	s-t-asmal	132	ž-t-aʕam	132

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[14] Examples include the pronunciations of English *to remunerate* as *to renumerate* (probably by analogy with *to enumerate* and *numerous*), as well as those of French *hypnotiser* 'to hypnotize' and *asphyxier* 'to asphyxiate' as *hynoptiser* and *axphysier*. Some metatheses have become standard, as in French *moustique* 'mosquito' (from Spanish *mosquito*, by analogy with French *tique* 'tick'). Some changes involve movement of a consonant rather than metathesis proper, as in popular French *infractus* 'infarct' and *aréoport* 'airport' for Standard French *infarctus* and *aéroport*. Blevins and Garrett (1998:525–527) discuss similar instances of liquids, pharyngeals, and glottals moving across words.

[15] The first *a* of this vocalic pattern is raised to *i* when it stands in an open syllable and is not immediately followed by a guttural consonant, liquids, or *n* (Al-Mozainy 1981:57).

(15) Ludlings involving root consonant reorderings in Moroccan Arabic

Regular form	
kṛmuṣ-a	1234
'fig'	
Game forms	
ṛṣkum-a	2413
mkṣuṛ-a	3142
ṣkṛum-a	4123
ṣmṛuk-a	4321

In Bagemihl's analysis, the only way to derive the reversals in (14) and (15) is to posit a context-free consonant exchange rule. If one assumes, as does Bagemihl, that only maximum and minimum crossing of association lines is allowed,[16] the reversal involved in the transformation of *ž-t-imaʕ* (123) into *ʕ-t-imaž* (321) requires one step: maximum crossing, that is, exchange between *ž* and *ʕ: ž-t-imaʕ → ʕ-t-imaž*. In the same ludling, the reversal involved in the transformation of *ž-t-imaʕ* (123) into *m-t-aʕaž* (231) requires at least two steps: (a) minimum crossing, that is, exchange between *ž* and *m: ž-t-imaʕ → m-t-ižaʕ*, and (b) minimum crossing, that is, exchange between *ž* and *ʕ: m-t-ižaʕ → m-t-aʕaž*. In Bagemihl's view, these ludlings are marked in two respects: (a) the exchange rule is not specified with respect to the environment in which it applies (the first and the third consonants in the first example and all three consonants in the second one), and (b) the exchange rule can be applied with either the maximum or the minimum crossing parameter setting. If we limit the crossing parameter to one setting, the first example can be derived with recursive minimum crossing only: (a) exchange between *m* and *ʕ: ž-t-imaʕ → ž-t-aʕam*, (b) exchange between *ž* and *ʕ: ž-t-aʕam → ʕ-t-ižam*, and (c) exchange between *ž* and *m: ʕ-t-ižam → ʕ-t-imaž*. Yet, for Bagemihl (1989), these consonant exchanges would still be marked not because of the recursiveness, as this is also needed for other ludlings, but because the derivation of the Arabic game forms requires more than one application of the *same* reversal process (consonant exchange). Other ludlings involving more than one reversal process in the derivation of a game form combine different types of reversal (e.g., syllable reversal is combined with consonant exchange in Burmese).

Let us note, however, that it is entirely accidental for permutation to be limited to dialects of Arabic. Bagemihl's account leads one to expect that random consonant reorderings should be equally likely outside of Semitic.

Arabic ludlings typically metathesize root consonants only, leaving all affixes unaffected. This is parallel to ZT's metatheses. Arabic ludlings also illustrate the psychological reality of

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[16] With respect to consonantal roots, crossing is minimum when the switched consonants are adjacent (e.g., 123 → 213) because as few association lines as possible are crossed. Crossing is maximum when the switched consonants are first and last (e.g., 123 → 321) because as many association lines as possible are crossed.

roots, but we believe that aphasic errors (and, as we will show in the next section, slips of the tongue) constitute a more compelling source of external evidence than ludlings do because they are not taught and are not subject to voluntary mental computations. Naturally, an analysis correlating random metathesis with an independent property of the language (here root-and-pattern morphology) is a priori desirable, but chance and cultural diffusion cannot be ruled out. Just as we do not consider that an unwritten language would not lend itself to writing, we cannot conclude from the absence of random reversals outside of Semitic that non-Semitic languages would not lend themselves to such ludlings. The only way to prove the existence of a correlation would be to teach randomly metathesizing ludlings to two groups of speakers under identical conditions and show that Semitic speakers learn them more easily than non-Semitic speakers do. We suspect that the results would be conclusive, but to our knowledge, such tests have never been conducted. In ZT's case, no doubt can be entertained because he was never shown, let alone taught, these segment reversals. The fact that he produces this specific pattern of errors without prompting and applies it only in Arabic reveals a deep-seated difference in the mental representations of his two languages.

2.3 Metathesis in Slips of the Tongue

Aphasic errors are more comparable to slips of the tongue than to ludlings because they are equally involuntary and free of instruction. Berg and Abd-El-Jawad (1996) examined consonant reversals in Jordanian Arabic and German, based on their own corpora, as well as consonant reversals in English, based on Stemberger's (1983) and other corpora. They observed that Jordanian Arabic and Germanic (German/English) errors display different properties.

First, only Arabic speakers produce tripartite reversals. Berg and Abd-El-Jawad excluded these errors from their study because of their focus on errors common to Arabic and Germanic, but this explicit mention adds a fourth instance to the random metatheses already noted in Bedouin Hijazi Arabic, Moroccan Arabic (ludlings), and Standard/Lebanese Arabic (ZT).

Second, they note that Germanic slips are sensitive to a (syllabic) Positional Constraint, whereby substitutions normally involve like syllabic constituents, that is, onset for onset or coda for coda (e.g., *pessimistisch* [pɛsi:mɪstɪš] 'pessimistic' → [pɛsi:mɪštɪs]). On the other hand, their Arabic slips are insensitive to this constraint (e.g., *ɣurf-a* 'room' → *ruɣf-a*). If we assume that this difference is due to underlying preanchoring (Germanic segments being preanchored whereas Arabic segments are unanchored because of nonconcatenative morphology), we have a rationale for why onset-coda metatheses are limited to Arabic because, in this language, floating consonants can be attached to either onset or coda depending on the template. If underlying floating root consonants are responsible for the irrelevance of the Positional Constraint in Arabic slips of the tongue, all root consonant metatheses—aphasic errors, ludlings, and slips of the tongue—have to take place before mapping since they leave vowels and infixes unaffected. Note however, that this explanation holds only if URs include root consonants on a tier other than that of templates and affixes (including aspectual vowels). If they included only fully formed words or vocalized

stems, there would be no explanation for why Arabic consonants alone are insensitive to syllabic positions. We will suggest in section 4.1.1 that this lack of preanchoring is also responsible for why metatheses are more frequent in ZT's Arabic than in his French.[17]

Recourse to floating root consonants also provides a better explanation for why randomly metathesizing ludlings are also limited to Arabic than do Bagemihl's recursive segment reversals because, as mentioned in the previous section, recursiveness does not correlate with any independent property of Arabic, whereas the absence of preanchoring does.

In this section, we have discussed both new and previous external evidence for the morphemic nature of Arabic roots. Recent external evidence for Semitic roots is also presented by Feldman, Frost, and Pnini (1995) and Frost, Deutsch, and Forster (1997), based on root priming in lexical decision and naming in Modern Hebrew, as well as by Davis and Zawaydeh (1999) and Zawaydeh and Davis (1999), based on hypocoristics in Jordanian Arabic.

3 External Evidence for Templates

Templates are central to most accounts of Semitic morphology. All morpheme-based theories form words by combining roots and templates whereas most word-based theories combine stems and templates. We have reviewed external evidence for roots from metatheses in aphasic speech, ludlings, and slips of the tongue. We will now show that template misselection errors from aphasic speech, ludlings, and slips of the tongue also provide external evidence for templates. In spite of this parallel typology of evidence, metatheses are intrinsically different from template misselections because reversing root consonants is a phonological operation whereas selecting the wrong template is a morphological one.

3.1 Template Misselection in Aphasic Speech

If errors can target morphemes, we also expect to find aphasics who make errors with the other morphemes making up a Semitic word, such as templates. ZT produces such errors. For instance, instead of *waasiʕ* 'wide', he produced *wasiiʕ,* which is a nonword using the template of *kabiir* 'big'. We will not base our discussion of template misselection on ZT's performance because his errors often also involve metatheses (e.g., *waasiʕ-a* 'wide (FEM)' → *waʕiis,* a nonword) and/or affix stripping (i.e., deletion of affixes; e.g., *xaal-a* 'maternal aunt' → *xaal* 'maternal uncle'). Instead, we will discuss evidence from an aphasic speaker whose errors are more straightforwardly interpretable because they are, for the most part, confined to template misselection. Barkai (1980) presents a case study of a young Israeli agrammatic aphasic patient, Dudu, who suffered traumatic

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[17] Berg and Abd-El-Jawad (1996:314) claim that Arabic slips of the tongue occur after root consonants have been mapped to the template. As far as we can see, their motivation for not invoking the floating nature of root consonants is that their data display more errors involving adjacent consonants (e.g., *k* and *t* in *aktab*) than nonadjacent ones (e.g., *k* and *t* in *katab*). In our view, there are more metatheses in Arabic than in Indo-European because consonants float before they are mapped to the template. At this early stage, Arabic consonants are more prone to metathesis than are Indo-European consonants. Once Arabic consonants have been mapped to the template, the usual preference to metathesize adjacent consonants holds in Arabic, as it does in other languages. Consequently, Arabic consonants have two configurations under which they can metathesize: before and after they have been anchored. Indo-European consonants have only the latter configuration.

brain damage and subsequently developed verbal pattern errors in his mother tongue, Modern Hebrew. Unlike ZT, Dudu does not make errors on roots.

We illustrate in (16) the verbal patterns of Modern Hebrew with *xašav* 'to think'.

(16) Verbal patterns of Modern Hebrew

		Past	Present	Future	Gloss
Pattern 1	(pa'al)	xašav	xošɛv	yaxšov	'to think'
Pattern 2	(nif'al)	nexšav	nexšav	yexašɛv	'to be thought/considered'
Pattern 3	(pi'el)	xišɛv	mexašɛv	yexašɛv	'to calculate/compute'
Pattern 4	(pu'al)	xušav	mexušav	yexušav	passive of verbal pattern 3
Pattern 5	(hif'il)	hexšiv	maxšiv	yaxšiv	'to consider/appreciate/ respect'
Pattern 6	(huf'al)	huxšav	muxšav	yuxšav	passive of verbal pattern 5
Pattern 7	(hitpa'el)	hitxašɛv	mitxašɛv	yitxašɛv	'to be considerate to/take into account'

As is the case for verbs in other Semitic languages, every Modern Hebrew verb can be conjugated in every tense but it is exceptional for a verb to select all patterns. This is why tenses are regarded as inflectional and patterns as derivational (see Aronoff 1994). The two verbs in (17) illustrate the fact that different verbs select different sets of verbal patterns.

(17) Patterns selected by two Modern Hebrew verbs

		šavar 'to break'	*tikɛn* 'to repair'
Pattern 1	(pa'al)	šavar	—
Pattern 2	(nif'al)	nišbar	—
Pattern 3	(pi'el)	—	tikɛn
Pattern 4	(pu'al)	—	tukan
Pattern 5	(hif'il)	—	hitkin
Pattern 6	(huf'al)	—	hutkan
Pattern 7	(hitpa'el)	—	—

As a consequence, the lexical information of any given verb must include not only its root consonants but also the largely idiosyncratic list of patterns it can select. In the mental lexicon, the lexical entry of a verb includes at least its semantic field, its root consonants, and the check marks indicating which patterns it selects. Even the composite meaning that a verb takes on when combined with a given pattern is often partly idiosyncratic. For instance, a comparison of Arabic *katab* 'wrote' and *k-t-atab* 'subscribed' with *našar* 'spread (TRANS)' and *n-t-ašar* 'spread (IN-TRANS)' reveals that they are parallel morphologically (verbal pattern 1 vs. verbal pattern 9) but not semantically. This is comparable to the observation that English *re-* does not make the same semantic modification to the stems *shape* and *turn* in *to reshape* and *to return*.

Dudu's errors typically leave the root consonants intact. He makes mistakes in producing

either patterns that are well formed for a given verb but are inappropriate syntactically, or patterns that are nonoccurring for that verb. In the first case, he matches the verb with the pattern that it would select in a different context. To illustrate this on the basis of Arabic, this first type of error would involve confusions between actual verbal patterns such as verbal pattern 1 *katab* 'wrote', verbal pattern 3 *kaatab* 'corresponded', and verbal pattern 9 *k-t-atab* 'subscribed'. Comparable errors in English would involve confusions between verbs of the same derivational family, such as *cover, uncover, discover,* and *recover*. In the second case, Dudu matches the verb with a pattern that it cannot select, thereby filling lexical gaps. In Arabic, this would involve producing verbal pattern 9 **q-t-araʔ* instead of verbal pattern 1 *qaraʔ* 'read'. Although **q-t-araʔ* would presumably be well formed and mean 'read (MIDDLE)' (as in 'this book reads easily'), it simply does not exist. Comparable errors in English would consist in creating verbs such as *unread, subread,* or *disread* when meaning *read*. Some of Dudu's errors are shown in (18).

(18) Errors produced by the aphasic patient Dudu (Barkai 1980)

Correct form	Pattern	Gloss	Output	Pattern
ləvate	3	'to pronounce'	livto	1 (nonoccurring)
šalax	1	'he sent'	šileax	3 (nonoccurring: archaic)
yisog	2	'he will retreat'	yasug	1 (nonoccurring)
yišbəru	1	'they will break'	yišavru	2 (occurring)
yəfutru	4	'they will be dismissed'	yipatru	2 (occurring)
higdilu	5	'they enlarged'	gadlu	1 (occurring)
higati	5	'I arrived'	hagati	1 (nonoccurring)
tibahalu	2	'you will be shocked'	tivhalu	1 (nonoccurring)

As his productions are either occurring but contextually inappropriate or nonoccurring but formally correct, it appears that Dudu has trouble accessing the selection part of his verb entries. He misplaces the check marks that belong to a given verb but not the consonants of the root.[18] Some examples of pattern misselections in Hijazi Arabic agrammatic speech can also be found in Safi-Stagni 1991:261, 1995:102.

Recall that autosegmental representations of Semitic stems include three levels: the root, the template, and the vocalic morpheme(s). We have just noted that aphasic errors can affect the root alone, the template alone, or the template together with vowels. We would also expect to find errors that affect the vocalic morpheme(s) only (producing, for example, *kutib → kitub* or *katub*), but we know of no clear examples in the literature other than the Amharic tongue twister to be discussed in section 3.3, and ZT did not produce any. This gap in error patterns may be due either to the fact that at present there are insufficient data on Semitic aphasiology or, as we suspect, to

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[18] Theories in which affixes select stems must claim that verbal patterns select roots, rather than the reverse (see Borer 1991:136). In such theories, it is the verbal pattern that includes idiosyncratic check marks stating what roots it selects. The interpretation of Dudu's linguistic deficit in this perspective would be that he has difficulty accessing the check marks in the subcategorization frames of his verbal patterns. Under both views, however, his problem seems to be an impaired access to subcategorization features.

the fact that autosegmental representations are not divided into three equal parts. The relationship between the pattern and the vocalic morpheme(s) is much closer than that between either of them and the root. This is why Dudu typically manipulates patterns and vowels together. In fact, there is little evidence that vocalic morphemes are mapped to templates in the way root consonants are. They may well be prelinked to templates, as in Guerssel and Lowenstamm's (1996) and Idrissi's (1997) treatments of Arabic verbs and nouns, respectively, and Idrissi's (2000) treatment of Berber nouns. So it is possible that templates and vocalic morphemes form a morphological subconstituent in the way most analyses assumed prior to the introduction of autosegmental representations.

Another observation we can make is that errors seem to be of two kinds: (a) creating a new root by changing the order of consonants (ZT's errors), or (b) selecting another template (Dudu's and some of ZT's errors). There seem to be very few errors in which new, nonexistent templates are created. This may reflect a strong tendency to produce possible words (i.e., words that may or may not exist but that obey the morphophonological constraints of the language). Clearly, though, these are early conclusions. Understanding the mechanics of template misselection will require, among other types of evidence, more descriptions of aphasic patients such as Dudu and ZT.

Given autosegmental representations, we should observe manipulations of the prosodic constituents of the template, such as syllables or moras. Errors that could be construed as involving syllable reversal were indeed occasionally produced by ZT: for example, $(_\sigma \mu\mu) (_\sigma \mu) \rightarrow (_\sigma \mu)$ $(_\sigma \mu\mu)$, as shown in (19).

(19) Apparent examples of syllable reversals

	Target	Gloss	Output
a.	waasiʕ	'wide'	wasiiʕ
	waasiʕ-a	'wide (FEM)'	waʕiis
	ħaliib	'milk'	ħaalib
b.	ʔa-ṭibb-aaʔ	'physician'	ʔa-ṭṭib-aaʔ
	hams	'whispering'	mhas

However, we think it more plausible that the errors in (19a) result from template misselection, rather than syllable reversal, since both input C*aa*C*i*C and output C*a*C*ii*C exist in the language. By contrast, the first error in (19b) cannot be due to template misselection since this output pattern does not exist in Arabic with initial gemination, though it is attested with an initial cluster, as in *ʔa-ṣdiq-aaʔ* 'friends'. On the other hand, the pattern of the second error in (19b) is unknown in Arabic.

3.2 Template Misselection in Ludlings

There are ludlings comparable to Dudu's template errors just as there are some that are comparable to ZT's root errors. Some pattern transfers are observed in Semitic ludlings that map a verb to a

verbal pattern that is contextually or lexically inappropriate. This is the case with the Gogot Gurage ludlings illustrated in (20a–d), from Leslau 1992:526ff. The shapes and functions of these verbal patterns are discussed by Chamora (1996), Lowenstamm (1996), Prunet (1996, 1998), Rose (1997), Banksira (2000, to appear), and Prunet and Chamora (to appear). Verbs are incorrectly mapped to the frequentative pattern in (20a) and to the compound verb pattern in (20b). In (20c), a consonant is added to a triliteral verb, which is then mapped to the pattern of quadriliteral verbs. In (20d), a verb is nominalized by mapping it to an inappropriate pattern, and an adjective is mapped to the wrong pattern.

The ludling illustrated in (20e) maps Amharic words to a pattern that does not exist in the standard language (see Demisse and Bender 1983, McCarthy 1984).

(20) Template misselection in Gurage and Amharic ludlings

Input	Gloss		Ludling form
a. kənna-m	'he prevented'	→	kinanna-m
tə-gʸenna-m	'he crossed over'	→	tə-ginanna-m
b. ekkəsə-m	'he waited'	→	əkʷakʷš breyə-m
kʷəččə-m	'he feared'	→	əkʷčač breyə-m
c. kəffətə-m	'he opened'	→	kiraffətə-m
qəbbət'ə-m	'he missed'	→	qɨrabbət'ə-m
d. noqqə-m	'it barked'	→	nugnug 'dog'
nəc'c'ə	'white'	→	nəc'əc'c'uwə
e. wəssəd-ə	'he took'	→	waysdəd
t'ɨk'ur	'black'	→	t'ayk'urər

It is likely that ludlings can lead to the creation of new roots and patterns when they become standard because the processes they employ are also attested in diachronic changes. This is clear with the addition of sonorants to Afroasiatic roots (Diakonoff 1988:42) and the creation of onomatopoeic and expressive patterns. The forms in (21) expressing noises in Lmnabha Moroccan Arabic, from Elmedlaoui 1995:57, illustrate how these two processes were involved in the transition from ludlings to dialectal forms. These patterns are now quite widespread throughout Morocco.

(21) Onomatopoeic forms in Lmnabha Moroccan Arabic

Onomatopoeia	Reinforced form	Superreinforced form	Derived verbs	
ttaq	ttraq	trtllaqq	tqtɨq	trtɨq
bbaʕʕ	bbraʕʕ	brbllaʕʕ	bʕbɨʕ	brbɨʕ
bbaqq	bbraqq	brbllaqq	bqbɨq	brbɨq
ddagg	ddragg	drdllagg	dgdɨg	drdɨg
ddaxx	ddraxx	drdllaxx	dxdɨx	drdɨx

The derived roots in the rightmost column behave like other quadriliteral roots in Moroccan Arabic, such as *xrbiq* 'he messed up'. For example, *trtiq* 'it exploded' can be used to form the inchoative (*tt-trtiq* vs. *tt-xrbiq*), the active participle (*m-trtiq* vs. *m-xrbiq*), and action nouns (*t-trtiq* vs. *t-xrbiq*).

3.3 Template Misselection in Slips of the Tongue

Template misselections are frequent in the speech of children (see Berman 1981:619 for Modern Hebrew examples). In adult speech, an Arabic slip of the tongue we observed recently is *ʔa-fdiy-aaʔ* 'self-sacrificing people', a nonexistent word formed from the root of *fidaaʔ-iy* 'self-sacrificing person' and the template of *ʔa-ṣdiq-aaʔ* 'friends'. Abd-El-Jawad and Abu-Salim (1987:149) report several Arabic slips of the tongue that also fall into this category.

(22) Template misselection in Arabic slips of the tongue

Target		Error	Literal target gloss
kalaam-ha ṣaḥiiḥ	→	ṣaḥaaḥ-ḥa kaliim	'her talk correct'
nabiil u kamaal	→	kamiil u nabaal	'Nabeel and Kamal'
ḥasan išqeer	→	šaqar iḥseen	'Hassan Shuqair'
ma-ṭluub ṭaabiʕ-aat	→	ma-ṭbuuʕ ṭaalib-aat	'wanted typists'
il-watar il-ḥassaas	→	il-ḥasas il-wattaar	'the favorite the subject'
sakt-a qalb-iyy-a	→	qalb-a sakt-iyy-a	'attack heart'
bu-rquṣ ʕa id-daqq-a	→	bi-duqq ʕa ir-raqṣ-a	'I dance to the beat'

In these errors, the two vocalized templates remain in situ while the two roots are switched. As a result, each root finds itself mapped to a template it should not select.

Similarly, the purpose of the following Amharic tongue twister is to entice speakers to err over the perfective template of (23a) and produce the nonword in (23b):

(23) a. al-an-<u>nazzəz</u>-accuh-accəw-imm
         NEG-CAUS-<u>confess</u>-you-them-NEG
         'you did not make them confess'
     b. al-an-<u>nəzaz</u>-accuh-accəw-imm

The induced errors involve the change from *zz* to *z* in the stem (/nəzzəz/) and the reversal of the stem vowels (/a-ə/). Neither the resulting template (CVCVC) nor the resulting vowel sequence (/ə-a/) is legitimate in an Amharic verb in the perfective aspect.

To conclude this survey of external evidence for the basic components of Semitic words: we have shown that there is a parallel typology of circumstances in which metathesis errors and template misselections are observed: aphasic errors (section 2.1 vs. section 3.1), ludlings (section 2.2 vs. section 3.2), and slips of the tongue (section 2.3 vs. section 3.3).

4 Formal Properties of Aphasic Metathesis Errors

We have argued that ZT's errors reveal an implicit knowledge of the root morpheme, but we must also provide more formal answers to the following two questions:

(24) a. Why does ZT produce more metatheses in Arabic than in French?
    b. Why does ZT produce more bipartite than tripartite metatheses in Arabic?

We will attempt to answer these questions on the basis of ZT's errors because they provide the only empirical evidence to which we have full access. Berg and Abd-El-Jawad's (1996) study of Arabic and German slips of the tongue in unimpaired speakers cannot be used to address question (24a) because it is based on corpora of errors collected from ''ambient conversations . . . monitored for unintentional ouput'' (p. 298), not from controlled stimulus sets such as those used in our study. As for question (24b), Berg and Abd-El-Jawad's study concurs with ours in reporting a greater proportion of bipartite than tripartite metatheses in Arabic, as will be discussed in section 4.2.

4.1 Why Are Arabic Metatheses More Frequent?

4.1.1 The Irrelevance of Phonotactic and Syllabic Constraints   Let us first address question (24a). Recall from (5a–b) that ZT produced 5 consonant metatheses in French as opposed to 119 in Arabic. It seems necessary to tie the generalization in (24a) to the morphemic and floating nature of Arabic root consonants compared to the nonmorphemic and preanchored nature of French consonants. Neither phonotactic nor syllabic constraints can explain the differences between the errors in these two languages.

Consider phonotactic constraints first. Arabic has no (or few) phonotactic constraints on the nature of CC clusters (other than homorganicity constraints that restrict the content of the root). This means that consonant reversals in errors such as *ṣufḥ-a* and *ʔa-nrab-aat* always result in the same C.C structure as that of the target forms—here, *fuṣḥ-a* and *ʔa-rnab-aat*. French does have phonotactic constraints (see Dell 1995), but this difference does not explain why ZT makes so few metatheses on French clusters. Some French clusters would be reversible without changing the syllable structure (e.g., *kt, tl,* where the structure is C.C in both orders), whereas some other clusters would be reversible with a concomitant change in syllable structure (e.g., *rk, rt,* where the structure is C.C in one order and .CC in the other). It appears, then, that phonotactic constraints cannot account for why ZT made 28 CC reversals in Arabic (e.g., *qird → qidr*) but only one in French: *ballerine* [balrin] → [parlin]. What is more, even in Arabic, most of ZT's metatheses (91/119 = 76.5%) do not involve clusters, which shows the limitations of any explanation based on phonotactic constraints.

Now, consider syllabic constraints. Recall from section 2.3 that Berg and Abd-El-Jawad's (1996) Germanic metatheses respect their Positional Constraint whereas their Jordanian Arabic ones do not. This is not the relevant difference in ZT's case because neither his French errors (e.g., *ballerine* [balrin] → [parlin]) nor his Arabic errors (e.g., *milʕaqa → miʕlaqa*) are sensitive to this constraint. Is it possible, then, that French branching onsets and codas make metatheses

more difficult than do the nonbranching onsets and codas of Arabic?[19] This would entail that French CVCVCV words such as *pédalo* 'pedal boat' would be propitious to reversals because no change in syllable structure would be involved. The lower rate of French errors would therefore stem from the fact that ZT's stimulus set did not contain enough words containing CV syllables only. To test this hypothesis, ZT was given a supplementary reading aloud task comprising 99 stimuli containing mostly CV syllables: 10 CVCV, 46 CVCVCV, and 16 CVCVCVCV word stimuli randomly mixed with 27 words containing other syllabic structures, such as CVC. The error rate in this test was very high: 71 errors out of 99 stimuli = 72% of errors. Among these 71 errors, 13 were semantic, 5 morphological, 9 visual, and 44 phonemic, but none included a consonant metathesis. Only one error, *chicané* [šikane] 'quarreled' → [šjɛ̃kɑ], may be construed as a metathesis error, but it would be one reversing vowels and consonants. Since even words composed of CV syllables fail to trigger metatheses, French syllable structure does not seem to be responsible for the lower rate of metatheses in this language. (See Béland and Paradis 1997 and Béland et al. 1999 for the effect of syllabic constraints in French-speaking aphasic patients.)

We maintain instead that the consonants of French are more stable than those of Arabic because they are preanchored. This entails that Arabic consonants are not preanchored, which means that they form roots. In both languages, the consonants are ordered, but the URs of Arabic roots need only contain precedence relations on one tier, as shown in (25).

(25) *UR of root* ktb *'write'*
     k   t   b

In Indo-European languages, URs must contain precedence relations on both melodic and skeletal tiers (e.g., *š* precedes *a,* which itself precedes *p* in French [šapo] 'hat'), in addition to information about how the units on both tiers are connected to one another.

(26) *UR of* chapeau *[šapo] 'hat'*
     š   a   p   o
     | | | |
     x   x   x   x

Whatever formalism is used to express precedence, the order of segments should be more stable in Indo-European than in Semitic because the links between the prosodic and segmental tiers are memorized, rather than derived by rules, principles, or constraints.

If ZT's errors originate from a deficit, common to both languages, in computing the precedence information, the higher frequency of consonant metatheses in Arabic must be imputed to differences between Arabic and French URs. Two characteristics distinguish these URs: (a) Arabic consonants float in UR, and (b) Arabic consonants and vowels occupy separate tiers because they belong to different morphemes. French segments cannot be said to float underlyingly for two reasons. First, some dialects of French have long consonants and long vowels whose positions must be learned for each word. Second, it is insufficient to preanchor long segments

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[19] We assume that the final CC clusters of Arabic do not form branching codas.

only and leave short ones floating because there are many (short) latent consonants that can be distinguished from (short) permanent ones only if the former float (see Tranel 1995 and Paradis and El Fenne 1995 for recent overviews). The position of these floating consonants is unpredictable: some are word-final (e.g., *petit* [pəti] 'small' vs. *rite* [rit] 'rite'), others are prefix-final (e.g., /deˢ-/ in *désunir* 'to disunite' vs. *détendre* 'to slacken'), and many floating nasals are word-internal (e.g., the one in *bandit* 'bandit', as Paradis and Prunet (2000) argue on the basis of borrowings). Preanchoring French segments therefore seems unavoidable. As there is no motivation for C/V segregation in French, the URs of these languages differ in at least these two ways. It is reasonable to assume that the combination of both characteristics in Semitic is responsible for consonant metatheses' being so frequent in this family. Languages with only one of these two characteristics seem unlikely to display free consonant metatheses. Languages with no preanchoring and no C/V segregation, such as Basaa in Schmidt's (1994) analysis, would have no reason to metathesize consonants only since consonants are mixed with vowels on the segmental tier. Finally, we know of no analysis advocating the existence of the other combination, that is, preanchoring and C/V segregation.

Within stem theories claiming URs to be the same in Semitic and non-Semitic languages, it could be argued that ZT's Arabic metatheses affect consonants only because Arabic has a constraint enforcing precedence relations between stem vowels. Whatever the empirical adequacy of such an analysis may be, we believe that it would contradict the basic premise of stem theories, which is that both Semitic and non-Semitic URs contain monomorphemic vocalized stems. Creating a constraint whose purpose is to allow reversals specific to the stem consonants of Arabic would amount to admitting that Arabic stem consonants are lexically different from their French counterparts. In our view, stem theories that likewise introduce processes of root extraction, transfer, or mapping that ignore Semitic vowels and affixal consonants all attempt to unify Semitic and non-Semitic word structure underlyingly but they reintroduce structural distinctions between Semitic and non-Semitic stem consonants later in the derivation. Our view is, rather, that UG allows morphemes to be specialized segmentally. They can be limited to vowels, consonants, and tones. Semitic simply exploits this option by having lexical morphemes containing (in most Semitic languages) only consonants.

4.1.2 Are ZT's Metathesis Errors Lexically Biased?   The floating root rationale accounts for the frequency of ZT's errors in Arabic but not for the fact that so many of them are lexically biased. Recall from section 2.1.4 that there is presumption of lexical bias when the output coincides with an existing word or root. ZT produced 83 metatheses (83/104 = 79.8%) in triliteral roots and 2 metatheses in quadriliteral roots (2/12 = 16.7%) that may be lexically biased, that is, whose outputs coincide with existing words, as in (11), and/or roots, as in (12). We ignore the 3 errors on biliteral roots because these have only one reordering (12 → 21). By contrast, he produced no output coinciding with an existing word in French. This difference in lexical bias between his Arabic and French errors may, indeed, be due to the simple fact that Arabic exploits far more combinations of consonant orders than French does.

Consider the set of 71 triliteral roots over which ZT made metathesis errors. From an initial input 123 order, each root could yield five alternative orders: 132, 213, 231, 312, 321. A search in Kazimirski's (1860) dictionary for how many of these 5 × 71 (= 355) alternative orders

correspond to existing roots shows that random reversal has twice as many chances to coincide with existing than with nonexisting roots.

(27) Alternative orders for the 71 triliteral roots that ZT metathesized

Alternative order	132	213	231	312	321
Nonroot	20	22	21	21	25
Root	51	49	50	50	46

From this limited sample of roots, it appears that Arabic exploits most of the orders predicted by free combination of root consonants, that is, 69.3% (246 of the 355 combinations). ZT's output triliteral roots happen to coincide with existing roots 79.8% (i.e., 83/104) of the time, a proportion that is slightly but significantly higher at a .05 level ($\chi^2 = 3.87$, $p = .049$). However, separate chi-squared analyses for the five reorderings were also conducted because the root subsets differ across the five reorderings and none of the five chi-squared values were significant at .05 level.

As for quadriliteral roots, a check in Kazimirski 1860 of how many of the 23 possible reorderings of the original 11 quadriliteral roots (i.e., $23 \times 11 = 253$) coincide with existing roots shows that only 32 of the possible combinations ($32/253 = 12.6\%$) coincide with existing roots. This is because quadriliteral roots are subject to known segmental constraints (such as the near obligatoriness of having a sonorant as second consonant). As reported earlier, the proportion of ZT's output quadriliteral roots coinciding with existing roots is $2/12 = 16.7\%$, a proportion that does not significantly differ from the one found in the dictionary ($\chi^2 = .001$, $p > .05$).

From these statistical analyses, we conclude that it is only by chance that ZT produced reorderings of triliteral and quadriliteral root consonants that coincide with existing roots.

4.1.3 Further Evidence for the Floating Root Consonants of Semitic   Let us return to our claim that the order of stem consonants is easier to disrupt in Arabic than in French. There are two other aspects of Arabic that can be mentioned in this context.

First, the ease of root consonant reversal in aphasia, ludlings, and slips of the tongue can be related to the fact that Arabic has a number of synonymous roots containing the same consonants in different orders. The examples in (28) are drawn from Bohas 1997, to which the page numbers refer. Expressions such as *verbal pattern 4* indicate that this root selects the 4th of the 15 verbal patterns of Arabic.

(28) Synonymous Arabic roots containing the same consonants in different orders

Page	Root	Word	Gloss	Root	Word	Gloss
7	brt	bart burt	'action of cutting' 'axe'	btr	batar-a	'to cut, to cut off the tail of an animal'
7	bšr	ʔa-bšar-a	'to grow herbs and plants'	rbš	rabiš-un	'having herbs of all kinds'
					ʔa-rbaš-u	'covered with plants (of land)'

98	bwx	baax-a /bawax/	'to calm oneself, to go out (of fire, heat, anger)'	bxw	baxa-a /baxaw/	'to calm oneself, to subside (of anger)'
112	ħwq	ħaaq-a /ħawaq/	'to sweep (with a broom)'	qwħ	qaaħ-a /qawaħ/	'to sweep (with a broom)'
113	ħkw	ħaka-a /ħakaw/	verbal pattern 4: 'to win, to get the better of someone'	kwħ	kaaħ-a /kawaħ/	verbal pattern 3: 'to beat someone, to have the upper hand'
123	rf	rafraf-a	'to spread and shake wings (of a bird)'	fr	farfar-a	'to shake, to shake one's body (of an animal)'
126	zl	zalzal-a	'to shake'	lz	lazlaz-a	'to be shaken'
130	sn	sann-a /sanan/	'to lead in front of oneself'	ns	nass-a /nasas/	'to lead in front of oneself'
134	ṭwʕ	ṭaaʕ-a /ṭawaʕ/	'to obey someone, to be at someone's disposal'	ʕṭw	ʕaṭa-a /ʕaṭaw/	verbal pattern 2: 'to serve someone'; verbal pattern 4: 'to be obedient, to allow oneself to be led'
136	ʕwq	ʕuwaaq	'noise produced in an animal's belly while walking'	wʕq	wuʕaaq	'noise produced in a horse's belly while walking'
137	ɣfn	ɣafan	'disease of dates which consists of dust that covers them and prevents them from ripening'	fɣn	faɣan	'disease of dates which consists of dust that covers them and prevents them from ripening'

The pair of Wello Amharic roots *k't'l* and *lt'k'* is comparable to these Arabic pairs. Both roots mean 'following' in *k'ət't'il-o* and *lət't'ik'-o* but they are distinct lexical entries since, among other reasons, *k'ət't'əl-ə* 'he continued, he fastened' is not paralleled by **lət't'ək'-ə*. Bohas (1997:64) notes that the existence of such pairs of roots in Semitic was identified at least as early as Cohen 1955:207, where it is stated that ''apparently triliteral roots seem to lend themselves easily to metathesis.''

Similar examples of root consonant reversals can be found in dialects of modern Arabic. In some cases, the metathesis is observable diachronically (29) whereas in others, the resulting doublets coexist in contemporary dialects or sociolects (30). On our assumption that frequent metathesis affects root consonants, the non-Semitic origin of the last four Egyptian Arabic words in (30) must be interpreted as evidence for a process of root extraction operating also on loanwords. Such a process is independently needed in the nativization of borrowings, as in the Moroccan

Arabic verb *dɨwwɨš* 'he showered', formed from the French noun *douche* [duš] 'shower'. It is also needed in first language acquisition since children are exposed to words, not abstract roots, though in our view they deconstruct and store these words as roots and templates after becoming aware of paradigmatic regularities.

(29) Diachronic root consonant reversals in Maghrebi Arabic

Classical Arabic	Moroccan Arabic	Tangier Moroccan Arabic	Gloss
dažaaž	džaž	ždad	'poultry'
laʕn-a	niʕl-a		'cursing'
zaʕm-an	zɨʕma	zɨmʕa	'presumably'
		Tahir Algerian Arabic	
ṛaɣaayif	ṛɣayɨf	ɣṛayɨf	'sort of bread'
	tɨkki	kɨtti	'to lean'

(30) Contemporary root consonant reversals in Egyptian Arabic

Standard Egyptian Arabic	Colloquial Egyptian Arabic	Gloss
ʔa-raanib	ʔa-naarib	'rabbits'
ma-sraħ	ma-rsaħ	'theater'
ħafar	faħar	'he dug'
kaʔiib	ʔikib	'sad'
ħaffaar-a	faħħaar-a	'mechanical shovel'
litr	ritl	'liter'
falsaf-a	falfas-a	'philosophy'
barṭamaan	baṭramaan	'glass/plastic jar or tin'
skindiriy-a	stinkiriy-a	'Alexandria' (*d → t* after *s*)

Zaborski (1991:1687–1688) provides more such examples from Arabic and other Semitic languages. Leslau (1992:97–98) also discusses similar metatheses in Gurage dialects, reproduced in (31). Some pairs cooccur in the same dialect whereas others belong to different dialects. As with the Egyptian Arabic words, metathesis is not limited to words of Semitic origin, which is again evidence for a root extraction process applying to all words in acquisition and nativization. The examples in (31a) are Semitic words, those in (31b) come mostly from Cushitic, and those in (31c) are of unclear origin. The number in the rightmost column refers to the page in Leslau's (1979) etymological dictionary where the origin of the word is discussed.

(31) Root consonant reversals in Gurage dialects

Dialectal form	Dialectal form	Gloss	Page
a. ibliis (<Arabic)	ilbis	'evil spirit'	8
gəzzərə, gərrəzə (<Amharic)	gərəzə	'to circumcise'	297
kəbəro	kərəbo	'drum'	334

kɨlkɨl	liklik	'armpit'	340
kəzəbə (<Arabic)	kəbəzə	'to lie'	359
kɨzb (<Arabic)	kɨbz	'people'	359
saβʔat	saʔabt	'seven'	534
sɨlət't'ənə (<Arabic)	sinət'ələ	'to have an education'	545
t'əbt'ət	t'ət'bət	'early morning'	608
t'ɨwəlləgə	t'oggələ	'to wither'	637
b. borkətta	botrəka	'crack in the ground'	163
fišara	firša	'sediment of water'	247
gʷədrət	gʷərdət	'mound around fireplace'	265
k'aššaweʔ	k'awše	'type of game'	506
arwa (<Arabic *arwaah*?)	awrə	'soul'	93
c. bɨrč'ək'k'o	bɨč'rɨk'k'o	'drinking glass'	152
bəttɨr	bərt	'stick'	163
gələmə	gʸəmmələ	'to sew leather'	309
ɨgzər	ɨzgɨr	'God'	28
kəsəl	səhəl	'charcoal'	353
ɨndəxrečə	ɨndərheččə	'kidney'	59
t'ulbuk'	t'ubuluk'	'to plunge into water'	617
at'met	amɟɨʔɨd	'solidified juice' (*t'* → *ʔ*)	109
wəfənča	wənəfč-ar	'doorway'	645
awsač	aswaččat	'trap'	667
wɨzgɨbbər	wɨzbɨggər	'repentance'	675
azgalɨd	azlagɨd	'cloth belt'	120

More diachronic examples of bipartite and tripartite reversals exist in Classical Ethiopic (Dillmann 1907:108) and Amharic (Cohen 1970:56).

We have surveyed five phenomena where Arabic and other Semitic languages distinguish themselves by the ease with which their consonants can be reordered, synchronically (32a–c) or diachronically (32d–e).

(32) a. Unusually high number of consonant reversals in aphasic speech
   b. Only known ludlings exhibiting random consonant reversals
   c. Unusually high number of consonant reversals in slips of the tongue
   d. Synonymous roots sharing the same consonants in different orders
   e. Diachronic consonant reversals

We have suggested that this ease of reversal is due to (a) the existence of roots, and (b) the fact that roots include floating consonants. Some metatheses are also found outside of Semitic, as in the aphasic errors and slips of the tongue noted in French (section 2.1.2) and Germanic (section 2.3), but much less frequently so. They are also (rarely) seen in historical data, as in the 100 cognate sets of Salish roots identified by Noonan (1997) whose consonants are ordered

differently in related languages, as in Shuswap $x^w ey$ 'disappear' and Twana $y\partial x^w$ 'disappear' (p. 482). These data are reminiscent of the historical Semitic metatheses illustrated in (29)–(31), but they can be explained in two other ways. First, Noonan raises the possibility that they may come from ancient ludlings, in which case they are not comparable to Arabic ludlings, since exchanging the first and last consonants of a CVC root does not qualify as random reversal. Second, these metatheses could be due to the predictability of segmental order since CVC is the most common root pattern in Salish. This would make the CVC pattern of Salish comparable to the default pattern of a Semitic language displaying a very small inventory of patterns. It is possible that the frequency of CVC roots in a small set of root structures prompts Salish speakers to store their consonants as floating underlyingly. In addition, there is evidence of some templatic morphology, as in the aspectual distinction in Klallam between /x̣íc'-/ 'scratch (ACTUAL ASPECT)' and /x̣c'í-/ 'scratch (NONACTUAL ASPECT)' (Czaykowska-Higgins and Kinkade 1998:22, 24). McCarthy (1989) suggests that consonants and vowels can stand on different tiers in languages that have rigid word structure or templatic morphology because the canonical shape of words contains enough information to dispense URs from storing the respective order of consonants and vowels. Since Salish seems to meet both conditions, it is possible that Salish roots include floating consonants and vowels on different tiers if their respective order can be derived from association conventions. Once consonants and vowels stand on separate tiers, we suggest, there is no motivation for them to be preanchored.

4.2 Bipartite and Tripartite Metatheses

Now consider question (24b). If root consonants can be reversed easily because they float in Arabic URs, why did ZT produce as many as 91 bipartite but as few as 13 tripartite errors in Arabic?

As mentioned in section 2.2, there are five possible permutations of three consonants. Three of them are bipartite (123 → 132, 213, 321) and two are tripartite (123 → 312, 231). If permutations were random, one would expect 3/5 = 60% bipartite reversals and 2/5 = 40% tripartite reversals, a distribution that differs from the one observed (91/104 = 87.5% bipartite and 13/104 = 12.5% tripartite). The difference is significant ($\chi^2 = 19.37$, $p < .0001$).

This disproportion is also present in Berg and Abd-El-Jawad's (1996) corpus of Jordanian Arabic slips of the tongue, which contains 316 bipartite and 24 tripartite metatheses, that is, 92.95% and 7.05%, respectively. It is, in fact, a surprising finding that the proportion of bipartite and tripartite metathesis errors is not statistically different in their Arabic corpus and ours ($\chi^2 = 2.42$, $p > .05$).

One possibility that would account for the higher proportion of bipartite metatheses would be a lexical bias, that is, a tendency for ZT to produce existing roots. This possibility is ruled out for two reasons. First, as established in section 4.1.2, ZT does not show a lexical bias; that is, he does not err in favor of existing roots more than chance predicts. Second, even if he did show such a bias, the distribution of existing and nonexisting roots in (27) is uniform across the five reorderings ($\chi^2 = 0.98$, $p > .05$). As a consequence, a tendency to produce an existing root would not account for a higher proportion of bipartite (reorderings 132, 213, 321) over tripartite

metatheses (reorderings 312, 231) since whatever the reordering chosen by ZT, the output root is twice as likely to coincide with an existing root as it is with a nonexisting one.

With a 1 to 9 imbalance, tripartite metatheses are much rarer than bipartite ones in Arabic, but the disproportion is even greater in Indo-European. As far as slips of the tongue are concerned, Berg and Abd-El-Jawad (1996) report 24 tripartite errors in Arabic and none in German even though their Arabic corpus is six times smaller than their German corpus ($N > 1000$ and $N > 6000$, respectively). In the Indo-European aphasic literature, tripartite metatheses are almost unknown. The largest corpus of metatheses is that of Blumstein (1973) for English. She states that among the 123 intramorphemic metathesis errors she collected, contiguous ones (e.g., *magazine* [mægəzin] → [mæzəgin]) were far more frequent than noncontiguous ones (e.g., *pastry* [peistri] → [preisti]).[20] Dressler (1990) reports one tripartite metathesis by an Italian-speaking aphasic: *sigaretta* 'cigarette' [sigaretːa] → [risagetːa]. Metathesis errors were also reported in studies of French-speaking aphasics. Lecours and Lhermitte (1969) mentioned 15 metathesis errors by two jargon aphasic patients: 5 of them involved a consonant and a vowel (e.g., *silhouette* 'silhouette' [siluɛt] → [siulɛt]), 3 involved the reversal of two elements of digraphs (e.g., *froid* 'cold' [frwa] → *friod*), 6 were bipartite consonant metatheses (e.g., *cravate* 'tie' [kravat] → [travak]), and only 1 was a tripartite consonant metathesis (*jardin* 'garden' [žardɛ̃] → [radžɛ̃]). In a study of 29 French-speaking aphasics, Béland (1998) reported 20 metatheses: 13 of them involved the reversal of a vowel and a consonant (e.g., *forêt* [fɔrɛ] 'forest' → [fɔɛr]) and 7 the reversal of two consonants (e.g., *gifle* [žifl] 'slap' → [žilf]). Finally, all 3 reversals reported by Valdois and Nespoulous (1994) are also bipartite (*moutarde* 'mustard' [mutard] → [murtad], *carton* 'cardboard' [kartɔ̃] → [krat], and *cafetière* 'coffee-maker' [kafœtjɛr] → [fakœtjɛr]). In summary, the Italian example [sigaretːa] → [risagetːa] and the French example [žardɛ̃] → [radžɛ̃] are the only two cases of tripartite metathesis known to us in the aphasic literature. If, as we have argued, bipartite metatheses are rare in Indo-European because they destroy the ordering information expressed by the underlying preanchoring of segments, it is correctly predicted that tripartite ones will be even rarer in this language family since they are even more destructive of the UR structure.

It appears, then, that metatheses, both in aphasic speech and in slips of the tongue produced by unimpaired speakers, are governed by a principle of minimal disruption. Metatheses are produced but those that disrupt less of the original order are favored. In the case of Arabic, the tendency toward minimal disruption can be captured by stating that it is preferable to displace two consonants rather than three, or that minimal crossing is favored over maximal crossing during the mapping of root consonants to the template. Outside of Semitic, the same formal alternatives are available: minimal movement or minimal line crossing, with the added property

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[20] Blumstein does not include her corpus, so we cannot reanalyze it according to the notions of bipartite versus tripartite and contiguous versus noncontiguous. She categorizes errors according to a measure of distance 1 (the consonant changes position either with the consonant nearest to it or with the vowel directly contiguous to it; e.g., *magazine* → *mazagine*, *colts* → *clots*), distance 2 (the consonant is moved around another consonant, with no reversal; e.g., *professor* → *pofressor*), and distance 3 (the consonant moves around two or more consonants; e.g., *pastry* → *prasty*). For the purpose of comparison, we approximate her terms and ours as follows: errors she classifies as distances 1–2 are treated here as contiguous; errors she classifies as distance 3 are treated here as noncontiguous.

that consonants are preanchored and interspersed with vowels. As a consequence, any movement of consonants or crossing of consonant-to-skeleton links is more disruptive than it is in Semitic and, hence, is correctly predicted to be less frequent.

Distinguishing between bipartite and tripartite metatheses is, in our view, useful because it predicts a frequency-based division of errors that matches ZT's errors. Equating minimal and maximal disruption with bipartite and tripartite, respectively, predicts a two-way frequency grada-tion that is confirmed by our empirical findings.

(33) Distribution of ZT's metatheses as bipartite and tripartite in triliteral roots

Bipartite ($n = 91$)	Tripartite ($n = 13$)
$123 \rightarrow 321 = 15$	$123 \rightarrow 231 = 5$
$123 \rightarrow 132 = 36$	$123 \rightarrow 312 = 8$
$123 \rightarrow 213 = 40$	

Within the class of bipartite metatheses, two subclasses can be distinguished according to whether they displace consonants that are contiguous ($123 \rightarrow 132$, $123 \rightarrow 213$) or noncontiguous ($123 \rightarrow 321$, $123 \rightarrow 231$, $123 \rightarrow 312$). Random permutations predict $2/5 = 40\%$ contiguous and $3/5 = 60\%$ noncontiguous metatheses. ZT actually produced $76/104 = 73\%$ contiguous and $28/104 = 27\%$ noncontiguous metatheses. This distribution differs significantly from the one ex-pected ($\chi^2 = 21.32$, $p < .0001$). The fact that contiguous metatheses are more numerous than expected is consistent with the logic of minimal disruption laid out earlier.

Several means of encoding minimal and maximal disruption are possible, but they do not seem to shed as useful a light on the data as does the division between bipartite and tripartite metatheses.

An anonymous reviewer suggests a classification based on the number of modifications made to the original linear order of consonants in the target 123 root; that is, 1 is before 2, 2 is before 3, and 1 is before 3. This approach predicts a three-way frequency distribution of metatheses, from the smallest to the largest number of violations of the underlying linear order. The most minimal disruption is predicted to be of type 1 ($123 \rightarrow 213$ and $123 \rightarrow 132$) because only one order is modified in the target. For instance, in 213, 1 is no longer before 2 but 1 remains before 3 and 2 before 3. A greater disruption would be that of type 2 ($123 \rightarrow 312$ and $123 \rightarrow 231$). In these two reorderings, two of the original linear orders are modified. For instance, in 231, 2 is no longer after 1 and 3 is no longer after 1. Finally, the greatest amount of disruption is predicted to be that of type 3 ($123 \rightarrow 321$). In this reordering, all three original orders are changed: 1 is no longer before 2, 1 is no longer before 3, and 2 is no longer before 3. The predicted frequency gradation is therefore type 1 > type 2 > type 3, from the smallest to the largest number of violations of the underlying consonant order.

Classifying ZT's 104 errors on triliteral roots according to this typology yields the following distribution: type 1 = 76, type 2 = 13, type 3 = 15. Type 3 metatheses are predicted to be the least frequent, but they are actually more frequent than type 2 metatheses. It thus appears that

the classification into bipartite and tripartite metatheses in (33) makes better predictions for the distribution of metatheses produced by ZT.

Applying the reviewer's suggestion to ZT's quadriliteral root errors predicts a four-way gradation: from one to four violations of the underlying linear ordering. This typology predicts the following empirical distribution of ZT's 12 errors: type 1 = 8, type 2 = 1, type 3 = 3, type 4 = 0. As expected, the highest frequency in the distribution corresponds to type 1; but it is also the only type of metathesis that is bipartite. As a consequence, our analysis equating minimal disruption with the smallest number of displaced consonants (or crossed association lines) makes the same prediction.

In this section, we have proposed that root consonants are floating and morphemic in Arabic but preanchored and nonmorphemic in French. This explains the quantitative difference in metathesis errors between the two languages. ZT's performance in French and Arabic being identical in all respects except for consonant metathesis, we conclude that the consonantal root is a morpheme in Arabic, on a par with affixes and the template. The external evidence documented here suggests that the lexical units of Semitic correspond exactly to the size of the traditional consonantal root. Some authors argue, instead, for lexical units that are larger or smaller than the root. Some claim that the vocalized word or stem is the basic unit of word formation (see, e.g., Mahadin 1982, Heath 1987, Bat-El 1994, Ratcliffe 1997, and Ussishkin 1999). In these models, the URs of Semitic words match those of Indo-European languages since both include preanchored consonants and vowels on the same segmental plane. The problem with this approach is twofold: (a) it does not seem to account for the evidence showing that several processes are sensitive to Semitic root consonants, and (b) it does not seem to explain why so many processes are sensitive to the vocalized stem in Indo-European but not in Semitic. A frequent argument put forth by stem theorists consists in showing the existence of rules transforming a stem into another stem without recourse to the root unit. However, we suggest that such rules do not argue against roots as much as they argue for the necessity of output-to-output rules. We do not exclude these rules as long as the stored lexical units contain roots on a distinct morphemic tier. Other authors, after Bohas (1997), claim that all triliteral roots are composed of two synchronic units: (a) a biradical lexeme Bohas calls the *etymon,* and (b) a meaningless sonorant extension. Yet our evidence points to no such division in metathesis errors: the only synchronic distinction identifiable in our aphasic data, ludlings, and slips of the tongue is, as far as can be determined, that between root consonants and affixes. This is unexpected for etymon theory since it recognizes etymons and stems, but not roots, as legitimate morphological constituents. However, doing justice to these alternative views would require systematic formal comparisons between etymon-, root-, and stem-based theories, a task beyond the scope of this article. These comparisons will have to account for the evidence presented in the aforementioned studies, as well as for that introduced here.

5 Conclusion

In this article, we have argued that the consonant metathesis errors produced by ZT, a bilingual Arabic-French aphasic patient, provide external evidence for the existence of roots as lexical units

in the mental lexicon of speakers of Arabic. These errors differ quantitatively (error rate) and qualitatively (error types) in his two languages. We have suggested that these differences are compatible only with models in which the URs of Semitic languages are fundamentally different from those of non-Semitic languages. Because ZT has parallel linguistic deficits in his two languages, his metatheses must arise during the phonological planning stage in both languages. The same deficit yields different effects because the phonological representations of these languages are different: the radical consonants of Arabic float on the root tier in URs whereas those of French are preanchored and interspersed with vowels. The existence of roots as lexical units implies the existence of morphemes as lexical units and therefore favors morpheme-based models of morphology, or at least models that can store morphemes on distinct tiers. Our evidence does not exclude the existence of output-to-output rules.

We have also shown that postulating different morphological representations for Semitic and non-Semitic words predicts a typology of aphasic deficits that is confirmed by the existing literature, at least as far as the root and template/vowel division is concerned. This typology was justified independently by showing that there exists a parallel typology of ludlings and slips of the tongue for Semitic and non-Semitic languages. This typology is based on phonological operations in Semitic, such as reversals of root consonants, and morphological operations, such as template misselections.

Finally, we have formalized the way in which consonant metatheses take place more easily in Semitic than elsewhere. This accounts not only for qualitative differences between Arabic and French but also for quantitative differences between and within these languages. Five types of evidence for the ease with which consonants can be reordered in Semitic were put forward, most of which set Semitic URs apart from those of other language families.

Appendix

The following is an exhaustive list of ZT's 119 Arabic metathesis errors sorted in alphabetical order by root. Outputs produced in the writing-to-dictation task are followed by *.

Target root	Target	Output	Target root	Target	Output
ʔðn	ma-ʔaaðin	ma-daaʔin	b(w)xr	baaxir-a	baarix-a
ʔnf	ʔis-t-aʔnaf-naa	ʔis-t-afneʔ	b(w)xr	bawaaxir	baraaxiw
ʔnf	ʔis-t-iʔnaaf	ʔis-t-ifnaaʔ	b(w)xr	bawaaxir	baxaarib
ʕbd	ma-ʕbad	ma-ʕdab	b(w)xr	bawaaxir	baxaawir
ʕdn	ma-ʕaadin	ma-daaʕin	bʕθr	baʕθar	baʕraθ
ʕmr	mu-s-t-aʕmir	mu-s-t-amʕir	bḍ	biiḍ	ḍiib
ʕqrb	ʕaqaarib	ʕanaaqib	brq	ʔi-briiq	ʔi-qbiir
ʕrž	ʕarž-aaʔ	ʕažr-aaʔ	bɣd	baaɣiḍ	baaḍiɣ
ʕšb	ʕušb	šuʕb	bɣd	buɣḍ	budɣ
ʕṭf	ʔis-t-aʕṭaf	ʔis-t-aʕfaṭ	bɣd	buɣḍ	ɣaḍab
ʕṭf	ʔis-t-aʕṭaf-naa	ʔis-t-aftaʕ-naa	bḥr	baḥr	ḥbr*
ʕṭf	ʔis-t-iʕṭaaf	ʔis-t-iftaaʕ	drž	ʔis-t-adraž	ʔis-t-ažrad
ʕṭf	mi-ʕṭaf	mi-ṭʕaf	drž	darraaž-a	dažraaž-a
ʕṭf	mu-s-t-aʕṭif	mu-s-t-aʕfiṭ	dxl	daxal	xadal

Target root	Target	Output	Target root	Target	Output
dxl	ma-dxal	xadal	rwħ	ʔis-t-iṛaaħ-a	ʔis-t-iħaaṛ-a
ðrf	ʔa-ðrif-a	ʔa-ðfir-a	šyṭn	šayaaṭiin	šaṭaayiin
ðrf	ʔa-ðrif-a	ʔa-fðir-a	sbħ	ma-sbaħ	ma-ħbas
ðrf	ðarf	ðafr	sqf	ʔu-squf	ʔu-fqus
fʔr	faʔr	farʔ	sqf	ʔu-squf	ʔu-fqus
fhd	fahd	hdf*			(repeated error)
fnžn	fanaažiin	fažaaniin	sqf	ʔu-squf	ʔu-qsuf
fqr	fuqaṛ-aaʔ	fuṛaq-aaʔ	sqf	saqf	faqs
frs	faṛas	fasaṛ	stð	ʔa-saatið-a	ʔa-saadis-a
frs	ma-fṛas-a	ma-ṛfas-a	sxy	saxaaʔ	xasa
frš	faṛaš-aat	fašaaṛ-aat	sžd	ma-sžid	ma-ždis
fšl	faašil	šaafil	ṣfħ	ṣafħ	ṣħb*
fšl	fašil	šafil	ṣfħ	ṣafħ-a	ṣħf-t*
fṣħ	fuṣħ-aa	ṣufħ-a	ṣmr	mi-ṣmaar	m-mṣaar*
fħṣ	faħaṣ	faṣaħ	ṣħf	mu-ṣħaf	m-ṣfħ*
fħṣ	fuħuuṣ	fuṣuuħ	ṣħf	ṣaħaaʔif	ṣafaaʔiħ
fħṣ	ta-faħħaṣ	t-ṣfr*	ṣħf	ṣaħaaf-a	ṣfaaħ-t*
fħṣ	ta-faħħuṣ	ta-ħaffuṣ	tby	tiby	tiyib
hdf	ʔis-t-ihdaaf	ʔis-t-ifdaah	tlfn	tilifuun	tfluun*
hms	hams	mhas	θyby	ʔiθyuubyaa	ʔabyuuθyaa
hrž	ma-hraž-aan	ma-rhaž-aan	tžr	ma-tžaṛ	ma-žtaṛ
kʔs	kuʔuus	kusuuʔ	ṭrbš	ṭarbuuš	ṭašbuur
ktb	ta-kaatub	ka-ta-atub	ṭrq	mi-ṭraq-a	mi-qtar-a
lʕq	ma-laaʕiq	ma-ʕaaliq	ɣrq	ya-ɣraq-uun	na-rqaʕ-uun
lʕq	mi-lʕaq-a	mi-ʕlaq-a	wqf	ʔa-wqaaf	ʔa-wfaaq
lʕq	mi-lʕaq-a	mi-ʕlaq-a	wqf	ta-waqquf	ta-qawwuf
		(repeated error)	wsʕ	waasiʕ-a	waʕiis
lwħ	lawħ-a	walħ-a	wžs	wažas	žawas
lymn	laymuun	malyuun	xnzr	xanaaziir	xazaaniir
lħm	ma-lħam-a	ma-ħlam-a	xrž	mu-xriž	mu-xžir
lħm	ta-laaħum	ta-laamuħ	žfn	ʔa-žfaan	ʔa-šbaan
msʔ	masaaʔ	smaaʔ*	žhd	ma-žhuud	ma-žduuh
msħ	masaħ	samaħ	žl	ma-žall-a	m-lž-t*
nbt	nabat	bint	žls	ma-žlis	m-lžs*
ndy	nidaaʔ	dinaaʔ	žnħ	žinħ	žiħn
nṣb	ma-nṣuub	ma-ṣnuub	zhr	ʔa-zhaaṛ	ʔa-zṛaah
nṭq	mi-nṭaq-a	m-ṭnq-t*	zhr	zahṛ	hzr*
nṭq	nuṭq	nuqṭ	zl	ta-zalzal	ta-lazlaz
nxl	naxl	xanl	zr	zaṛṛ-aat	zazṛ-aat
nzl	ma-naazil	ma-laazin	zr	zirr	ṛizz
qbṭn	qubṭaan	quṭbaan	zrf	zaṛaaf-a	zafaaṛ-a
qrd	qird	qidr	zrf	zaṛaaf-a	zfraa-t*
qrd	quruud	quduur	ħbl	ħubul	ħulub
qws	qaws	swṭ*	ħml	ʔiħ-t-imaal	ʔiħ-t-ilaam
rʔs	ruʔas-aaʔ	rusaʔ-aaʔ	ħmq	ħamq-aaʔ	ħaqm-a
rkz	ma-ṛkaz	m-krz*	ħṣd	ħaṣṣaad	ṣaħħaad
rnb	ʔa-rnab-aat	ʔa-nrab-aat			

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