An algebraic approach to Arabic sentence structure

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We employ the notion of a pregroup grammar to describe sentence structure in a fragment of Modern Standard Arabic. The emphasis is on syntax, but inflectional morphology also plays a rôle in how words are strung together.

1. The algebraic machinery.

Pregroup grammars have been used to study sentence structure in a number of European languages [3,5,8,9]. We here turn to Arabic [1,2,6] as our first example of a non-European (and non-Indo-European) language. As it turned out, for the fragment of Arabic we investigated, only a small part of the algebraic machinery of pregroups was needed, which we will briefly summarize.

The main idea is to attach to each word, sometimes also to morphemes, one or more types. To start with, one assumes as given a partially ordered set of basic types, for example, $s_0$ and $s_1$ for declarative sentences in the past and present tense, respectively, and $s$ for such sentences when the tense is irrelevant. One postulates $s_0 \rightarrow s$ and $s_1 \rightarrow s$, where the arrow denotes the given partial order. From the basic types one forms simple types: thus from $a$ one obtains $a^\ell$ and $a^r$, which we call the left and right adjoint of $a$ respectively. For modern European languages also double adjoints $a^{\ell\ell}$ and $a^{rr}$ were required, but iterated adjoints don’t seem to play a rôle in the fragment of Arabic we have investigated so far.

The types to be attached to words are strings of basic types. For example, the word lam will have type $s_0s_3^\ell$, where $s_3$ (another basic type) is the type of a clause in the jussive mood.

The only rules we require here are the contractions

$$a^\ell a \rightarrow 1, \quad aa^r \rightarrow 1,$$

where 1 is the empty string. For example, lam yaktub (= he did not write) has type

$$(s_0s_3^\ell)s_3 = s_0(s_3^\ell s_3) \rightarrow s_0 1 = s_0,$$

which implies that this expression is a declarative sentence in the past tense.\(^{1)}\)

2. Conjugating the verb.

We have studied the finite verb forms elsewhere [4] and shown that they can all be calculated from a formal expression $C_{tkji}(V)$. Here:

(1) $V$ is the verb stem, usually given by three consonants (radicals) and two characteristic vowels. (There are also verbs with four consonants, but these we shall ignore here.)
(2) \(i = 1, 2m, 2f, 3m, 3f, 4, 5m, 5f, 6m, 6f\) stands for the three persons singular followed by the three persons plural; \(m\) means masculine and \(f\) means feminine. (There are also some dual forms, but these we shall ignore in this paper.)

(3) \(j = 0, 1, 2, 3\) stands for the tense-mood, 0 for the past, 1 for the present indicative, 2 for the subjunctive, 3 for the jussive. Later, we shall also meet \(j = 4\) for the future, which may be obtained with the help of a prefix \(sa+\) from the present tense.

(4) \(k = 1, \ldots, 10\) stands for the pattern, usually called "form". These ten patterns are constructed from the basic pattern \((k = 1)\) under which they are to be found in the standard dictionaries and to which they are loosely connected in meaning.

3. Typing the verb.

We distinguish between transitive verbs, which require an object, and intransitive verbs, which don’t. As in English, many verbs can be either transitive or intransitive. A verb must be intransitive when \(\ell = 2\) (passive) or when \(k = 7\) or 9. First, look at intransitive verbs \(V\):

\[C_{tkji}(V)\text{ has type } s_j\text{ in verbal sentences.}\]

In verbal sentences, the subject may be incorporated in the verb, as is assumed above, but it can also appear explicitly; but then the third person plural agrees with the third person singular of the verb, thus:

\[C_{tkji}(V)\text{ has type } s_j \pi_i^\ell \text{ when } i \neq 6g\]
\[\text{but } s_j \pi_3^\ell \text{ when } i = 6g\]

Here \(\pi_i\) is the type of the \(i\)-th person subject. When \(V\) is transitive, replace \(s_j\) by \(s_j o^\ell\) in the above, where \(o\) is the type of the object.

4. Tense modifiers.

Certain morphemes will change the tense-mood of a verb form. Thus,

\(sau\) and the prefix \(sa+\) have type \(s_3 s_1^\ell\), transforming the present tense into the future. Moreover, the following morphemes all denote negatives:

\(-lam\) of type \(s_0 s_3^\ell\), transforming the jussive into the negated past tense;
\(-laa\) of type \(s_1 s_1^\ell\), transforming the present tense into the negated present;
\(-lan\) of type \(s_4 s_2^\ell\), transforms the subjunctive into the negated future.

Here are some illustrations, using the transitive verb \(V = (k, t, b; u, a)\) with \(\ell = 1, k = 1\) and \(i = 3m:\)

\[
\begin{align*}
(1) & \quad sau\, yaktubu\, risalatan \\
& \quad (s_4 s_1^\ell) (s_1 o^\ell) \quad o \quad \rightarrow s_4
\end{align*}
\]

\[
\begin{align*}
(2) & \quad sa\, +\, yaktubu\, risalatan \\
& \quad (s_4 s_1^\ell)(s_1 o^\ell) \quad o \quad \rightarrow s_4
\end{align*}
\]
(3) \( \text{lam yaktub risalatan} \) \( (s_0s_0^f) (s_3o^f) o \rightarrow s_0 \)

(4) \( \text{laa yaktubu risalatan} \) \( (s_1s_1^f) (s_1o^f) o \rightarrow s_1 \)

(5) \( \text{lan yaktuba risalatan} \) \( (s_4s_1^f) (s_1o^f) o \rightarrow s_4 \)

(6) \( \text{saufa laa yaktubu risalatan} \) \( (s_4s_1^f) (s_1s_1^f) (s_1o^f) o \rightarrow s_4 \)

In English translation:

(1;2) he will write a letter

(3) he did not write a letter

(4) he does not write a letter

(5;6) he will not write a letter

5. To be or not to be.

Arabic has two “auxiliary” verbs which translate the English copula *to be* and its negation in certain contexts. While the English copula requires a nominative complement, these Arabic verbs are transitive, requiring an object in the so-called accusative case. The two verbs are:

\[
V_1 = (k, (w), n; u, u) \\
V_2 = (\ell, (y), s; -, a)
\]

Both are so-called “hollow” verbs, the middle radical being a potential \( w \) or \( y \), which may disappear in certain contexts.

\( V_1 \) is only known to us in three tense-moods: the past \( (j = 0) \), the jussive \( (j = 3) \) and the future \( (j = 4) \). It is used to translate the English verb *to be*, except in the present tense.\(^3\)

According to the rules \(^4\) established in [4], the forms of \( V_1 \) in the past tense should be as follows:

\[
\text{kuntu, kunta/kunti, kaana/kaanat, kunnaa, kuntum/kuntunna, kaanuu/kunna,}
\]

the three persons singular followed by the three persons plural, with different masculine and feminine forms in the second and third person. The forms of the jussive are calculated as follows:

\[
\text{'akun, yakun/takun, yakun/takun, nakun, takunuu/takunna, yakunuu/yakunna.}
\]

From the jussive one can calculate the present, which does not seem to exist independently, but which gives rise to the future with the help of the prefix \( sa^+ \). Here are some examples:

\[
kuntu \text{ taaliban} = \text{I was a (male) student} \\
(s_0o^f) o \rightarrow s_0
\]
kaana Saliman ëleban = Salim was a student
\((s_0 \omega^f_3 \pi^e_3) \pi_3m \ o \rightarrow s_0\)

sa’akuna ëleban = I will be a (female) student
\((s_4 \omega^f) \ o \rightarrow s_4\)

lam yakun Saliman ëleban = Salim was not a student
\((s_0 s_3^f) (s_2 \omega^f \pi^e_3) \pi_3m \ o \rightarrow s_0\)

The forms of \(V_2\) are formally in the past tense, but semantically in the present, so we assign to them the types \(s_1 \omega^f\) and \(s_1 \omega^f \pi^e_1\). They are:

lastu, lasta/lasti, laiisa/laiisat, lasnaa, lastum/lastunna, laiisuu/lasna.

Here are some examples:

lastu èleban = I am not a (female) student
\((s_1 \omega^f) \ o \rightarrow s_1\)

lasnaa èmes = we are not students
\((s_1 \omega^f) \ o \rightarrow s_1\)

laiisa Salimun èleban = Salim is not a student
\((s_1 \omega^f \pi^e_3) \pi_3m \ o \rightarrow s_1\)


Whereas the verb is marked for voice, pattern, tense and person, the noun and the adjective are marked for gender, number, case and definiteness. Many nouns have fixed gender, but adjectives and some nouns (such as ëleban) have variable gender. We will sketch a computational approach to the inflectional forms of the noun \(N\), to be generated by the expression \(D_{gcd}(N)\), where \(g = m \ or \ f\) is the gender (masculine or feminine), \(n = 1, 2 \ or \ 3\) is the number (singular, dual or plural), \(c = 1, 2, 3\) denotes the three cases nominative, accusative and a third case which resembles the Latin genitive or ablative, depending on the context, and \(d = 1, 2\) denotes definite and indefinite respectively.\(^5\)

The following formulas should generate all the inflectional forms of the noun \(N\). (The arrow here should not be confused with the arrow for calculating types.)

First, ignoring the determiner, we write

\[D_{m1c}(N) \rightarrow NV_c\]
\[D_{f1c}(N) \rightarrow N at V'_c\]
\[D_{m3c}(N) \rightarrow N^*V''_c V'' na\]
\[D_{f3c}(N) \rightarrow Naat V''\]

Here \(N\) is the noun stem, exceptionally replaced by \(N^*\), where \(N^* = N\) for most nouns, but \(N^* \neq N\) for a few, but frequently occurring nouns. E.g.,

\((mudarris)^* = mudarris\), but \((ëleban)^* = ëleaab\).
The vowels \( V_c, V'_c, V''_c \) are calculated as follows:

\[
V_c = u/a/i, \quad V'_c = u/a/a, \quad V''_c = u/i/i
\]

when \( c = 1/2/3 \) respectively.

For common nouns, we distinguish three cases:

\[
\begin{align*}
D_{gnc1}(N) & \rightarrow \text{al} + D_{gnc}(N) \\
D_{glc2}(N) & \rightarrow D_{glc}N + n \\
D_{g2c2}(N) & \rightarrow D_{g2c}N.
\end{align*}
\]

Note that, in spoken Arabic,

\[\text{al} \rightarrow aC \text{ before certain consonants } C.\]

Paradoxically, names are treated morphologically as indefinite nouns, though syntactically they are viewed as definite. Thus we should add:

\[
D_{g1c1}(N) \rightarrow D_{g1c}(N) + n \quad \text{when } N \text{ is a name.}
\]

7. Typing nouns and subject pronouns.

We assign types to various declensional forms of the noun \( N \) as follows:

\[
D_{gnc}(N) : n_{gnc}, \quad D_{gncd}(N) : n_{gncd}.
\]

It follows that articles should be assigned types thus:

\[
\begin{align*}
al & : n_{gnc1}n_{gnc}^\ell, \\
n & : n_{glc}n_{glc2}.
\end{align*}
\]

Since no article is required for plurals, we should postulate

\[
n_{g3c} \rightarrow n_{g3c2}.
\]

To describe the rôle of nouns in a sentence so far, we postulate:

\[
\begin{align*}
n_{gn1d} & \rightarrow \left\{ \begin{array}{ll} 
\pi_{3g} & \text{if } n = 1, \\
\pi_{6d} & \text{if } n = 3,
\end{array}\right. \\
n_{gn2d} & \rightarrow \text{o}.
\end{align*}
\]

The case \( c = 3 \) will be considered later.

There are also personal pronouns \( P_{ic} \), when \( i = 1, 2g, 3g, 4, 5g, 6g. \) Provisionally, we shall say \( P_{ic} \) has type \( \hat{\pi}_{ic} \). So far, we have only mentioned subject pronouns, so we postulate

\[
\hat{\pi}_{ic} \rightarrow \left\{ \begin{array}{ll} 
n_{g1c1} & \text{if } i = 1, 2g, 3g, \\
n_{g3c1} & \text{if } i = 4, 5g, 6g.
\end{array}\right.
\]
Note that all pronouns are considered to be definite, so $d = 1$. It follows that

$$\hat{\pi}_{i1} \rightarrow \begin{cases} 
\pi_{3g} & \text{if } i = 1, 2, 3, \\
\pi_{6g} & \text{if } i = 4, 5, 6.
\end{cases}$$

Oblique cases of personal pronouns will be considered later.

8. **Equational sentences.**

A verbless equational sentence joins together two nominative noun phrases agreeing in gender and number, but only exceptionally both are definite. The easiest way to fit such sentences into our algebraic picture, is to assume an invisible copula $\emptyset$ of types

(1) $s_1 n_{gn12}^{e} n_{gn11}^{f}$

and

(2) $s_1 n_{gn11}^{f} (\hat{\pi}_{i1})^{f} n_{gn11}^{e}$

The first type ensures that an equational sentence usually consists of a definite noun phrase followed by an indefinite one, agreeing in gender and number. The second type ensures that exceptionally an equational sentence may consist of two definite noun phrases with an optional pronoun between them.

Equational sentences are verbless and always represent the affirmative present. To form the past or the negation of an equational sentence, one requires the auxiliary transitive verbs of Section 5.

Examples where the invisible copula, here indicated by $\emptyset$, has type (1):

$$\emptyset \text{ ana } \text{ taliban} = \text{ I am a (male) student}$$

$$P_{11} \text{ } D_{m112}(\text{talib})$$

$$(s_1 n_{m112}^{e} n_{m111}^{f}) \hat{\pi}_{1m1} \rightarrow s_1 \quad (\text{using } \hat{\pi}_{1m1} \rightarrow n_{m111})$$

$$\emptyset \text{ anta } \text{ arabian} = \text{ you (male) are an Arab}$$

$$\emptyset \text{ Faridun } \text{ taliban} = \text{ Farid is a (male) student}$$

The last two examples are similar to the first. However:

$$\emptyset \text{ ana } \text{ taalibatun} = \text{ I am a (female) student}$$

$$\emptyset \text{ hia } \text{ taalibatun} = \text{ she is a student}$$

$$(s_1 n_{f112}^{e} n_{f111}^{f}) \hat{\pi}_{3f1} \rightarrow s_1 \quad (\text{using } \hat{\pi}_{3f1} \rightarrow n_{f111})$$

Examples when the copula has type (2):

$$\emptyset \text{ hua } \text{ alaawalu} = \text{ it is the first}$$

$$(s_1 n_{m111}^{e} n_{m111}^{f}) \hat{\pi}_{3m1} \rightarrow s_1$$

$$\emptyset \text{ almudiiru hua } \text{ ra'issu alaajnati}$$

$$\ldots \quad n_{m111} \quad \hat{\pi}_{3m1} \rightarrow n_{m111}$$
he is the committee chairman


The personal pronoun \( P_{ic} \) may occur in the nominative when denoting the subject (although this is usually absorbed in the verb) and in the oblique forms: accusative and genitive. The latter are identical, except in the first person singular, and are attached to the verb and noun respectively. The genitive pronoun may also be attached to a preposition, often producing a verbless sentence.

<table>
<thead>
<tr>
<th></th>
<th>( P_{1} )</th>
<th>( P_{12}/P_{13} )</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>ana</td>
<td>((u))nii/(ii)</td>
</tr>
<tr>
<td>2m</td>
<td>anta</td>
<td>+( ka )</td>
</tr>
<tr>
<td>2f</td>
<td>anti</td>
<td>+( ki )</td>
</tr>
<tr>
<td>3m</td>
<td>hua</td>
<td>((huh) )</td>
</tr>
<tr>
<td>3f</td>
<td>hia</td>
<td>+( haa )</td>
</tr>
<tr>
<td>4</td>
<td>nahnu</td>
<td>+( nna )</td>
</tr>
<tr>
<td>5m</td>
<td>antum</td>
<td>+( kum )</td>
</tr>
<tr>
<td>5f</td>
<td>antunna</td>
<td>+( kunna )</td>
</tr>
<tr>
<td>6m</td>
<td>hum</td>
<td>+( hum )</td>
</tr>
<tr>
<td>6f</td>
<td>hunna</td>
<td>+( hunna )</td>
</tr>
</tbody>
</table>

\((u) \rightarrow \begin{cases} u & \text{after } m \\ \emptyset & \text{otherwise} \end{cases}\)

\((ii) \rightarrow \begin{cases} a & \text{after } i \\ ii & \text{otherwise} \end{cases}\)

\((hu) \rightarrow \begin{cases} hi & \text{after } i \\ hu & \text{otherwise} \end{cases}\)

The accusative pronoun will be given type \( \hat{\pi}_{i2} \rightarrow o \),

thus transforming an incomplete sentence of type \( s_{j}o^{f} \) into a complete one:

\((s_{j}o^{f})\hat{\pi}_{i2} \rightarrow s_{j}o^{f}o \rightarrow s_{j} \).

Here are some examples:

\( taraktu + ki \) \rightarrow \( taraktuki = \) I left you (female)

\( (s_{0}o^{f}) \hat{\pi}_{12} \rightarrow s_{0} \)

\( tarakti + (u)\)nii \rightarrow \( taraktinii = \) you (female) left me

\( (s_{j}o^{f}) \hat{\pi}_{2f2} \rightarrow s_{0} \)

\( taraktum + (u)\)nii \rightarrow \( taraktumunii = \) you (male plural) left me

\( (s_{0}o^{f}) \hat{\pi}_{5m2} \rightarrow s_{0} \)

\( lam yatruk + (u)\)nii \rightarrow \( lam yatrukniu = \) he did not leave me

\( (s_{0}s_{3}^{f}) (s_{3}o^{f}) \hat{\pi}_{12} \rightarrow s_{1} \)
The case \( c = 3 \) of a personal pronoun differs from the accusative case \( c = 2 \) only in the first person. If the pronoun \( P_{i3} \) is attached to a noun, we think of it as being in the genitive case. But if it is attached to a preposition, a comparison with Latin would suggest that it is in the ablative case. Morphologically, the genitive and ablative cases coincide, but, syntactically, they behave differently.

10. Personal pronouns attached to prepositions.

After the personal pronoun \( P_{i3} \) is attached to a preposition, the subscript \( i \) becomes irrelevant, hence we introduce the basic type \( \gamma \) for such a pronoun and postulate

\[
\hat{\pi}_{i3} \rightarrow \gamma.
\]

To keep this article within reasonable bounds, we will consider only three types of prepositional phrases:

- possessive of type \( \pi \),
- dative of type \( \delta \),
- locative of type \( \lambda \).

We can now assign types to prepositions as follows:

<table>
<thead>
<tr>
<th>preposition</th>
<th>type</th>
<th>translation</th>
</tr>
</thead>
<tbody>
<tr>
<td>( ila )</td>
<td>( \pi\gamma^\ell )</td>
<td>of</td>
</tr>
<tr>
<td>( ila )</td>
<td>( \delta\gamma^\ell )</td>
<td>to</td>
</tr>
<tr>
<td>( fi, rala, ran )</td>
<td>( \lambda\gamma^\ell )</td>
<td>in, on, about</td>
</tr>
</tbody>
</table>

Here is a typical example:

\[
katabtu \ risalatan \ ila + ka
\]

\[
(s_0\delta^\ell o^\ell) \ n_{f122} \ (\delta\gamma^\ell) \ \hat{\pi}_{2m3} \rightarrow s_0
\]

= I wrote a letter to you (male).

Note that *katabtu* here has type \( s_0\delta^\ell o^\ell \), although it can have type \( s_0 o^\ell \), used intransitively, \( s_0 o^\ell \) when used transitively, or even \( s_0\delta^\ell \), as in “I wrote to you”. All this, if the subject is not mentioned. Presumably, the dictionary would list the type of *katab* as \( s_0(\delta^\ell)(o^\ell)(\pi_{3m}^\ell) \).

The form *risalatan* is the accusative singular of a feminine noun with indefinite article. We recall that \( n_{gn2d} \rightarrow o \).

The preposition *ila* is the preposition translating English “to” (in the dative, not locative sense) and the morpheme *ka* is the masculine second person pronoun. We recall that \( \hat{\pi}_{i3} \rightarrow \gamma \).
The preposition *la* (= of) can also occur in verbless sentences, which we may parse with the help of an invisible copula. For example:

$$\emptyset \text{ lii } ibnun$$

$$(s_1 \pi_3^g \pi^f) \pi \mathbf{n}_{n112} \rightarrow s_1$$

$$= \text{ I have a son (= mine [is] a son).}$$

Note that *lii* arises as follows:

$$la + (ii) \rightarrow lii$$

$$(\pi^f \pi^f) \pi \rightarrow \pi$$

if we recall that $\hat{\pi}_{i3} \rightarrow \gamma$.

The invisible copula has type $s_1 \pi_3^f \pi^f$ when $i = 3g$ or $6g$, and we recall that $\mathbf{n}_{g11d} \rightarrow \pi_{3g}$.

The form *ibnun* is the nominative singular of the masculine word *ibn* with indefinite article.

11. **Personal pronouns attached to nouns.**

The oblique personal pronoun $P_{i3}$ may be suffixed to a noun without article rendering it definite. Thus it may be compared to a definite article, although this is attached as a prefix. We could explain this by assigning to $P_{i3}$ the type $n_{gnc}^r n_{gnc}$:

$$D_{gnc}(\mathbf{N}) P_{i3}$$

$$\mathbf{n}_{gnc}(n_{gnc}^r n_{gnc}) \rightarrow n_{gnc}$$

The reader might wish to explain this by a rule

$$\pi_{i3} \rightarrow n_{gnc}^r n_{gnc}$$

or, equivalently,

$$\mathbf{n}_{gnc} \pi_{i3} \rightarrow n_{gnc}.$$

Unfortunately, such rules are not admitted in the kind of grammar we are advocating, which permits rules $x \rightarrow y$ only when $x$ and $y$ are basic types.

To get around this, we propose a “metarule”, which affects the dictionary only, asserting that any noun $D_{gnc}(\mathbf{N})$ without article has not only type $\mathbf{n}_{gnc}$, but also type $\mathbf{n}_{gnc} n_{gnc}^\gamma$. One might say that the noun then no longer denotes a thing but a relation. Here are some examples:

- $maktebu + ka = \text{ your office}$
  $$(\mathbf{n}_{m111} \gamma^f) \gamma \rightarrow \mathbf{n}_{m111}$$
- $fi maktebi + ka = \text{ in your office}$
  $$(\lambda^f \mathbf{n}_{m131} \gamma^f) \gamma \rightarrow \lambda$$

This requires the postulate

$$\mathbf{n}_{gnc1} \rightarrow \gamma,$$
from which the earlier rule $\hat{\pi}_{i3} \rightarrow \gamma$ follows.

$$
\text{sa} + \text{yakun al} + \text{ustaazu fi maktabi} + \text{hi}
\begin{array}{c}
(s_i\ell s_i^f) (\lambda n^\ell n_{gnc}^\ell m_{m11}^n) (\lambda n^\ell n_{gnc}^\ell m_{m11}^n) (\lambda n^\ell n_{gnc}^\ell m_{m11}^n) \\
\end{array}
\begin{array}{c}
\hat{\pi}_{3m3}
\end{array}
= \text{the professor will be in his office}
$$

The analysis requires that \textit{yakun}, the present third person masculine of the verb “to be somebody”, has not only type $s_i\ell o^\ell \pi_{3m}^\ell$, but also type $s_i\ell s_i^f$ in the sense of “to be somewhere”. We also recall that the assimilation

$$(hu) \rightarrow hi \text{ after } i$$

$\hat{\pi}_{3m3} \rightarrow \gamma$.


We will stop our investigation at this point, even though we had planned to discuss other grammatical phenomena, such as duals, doubly transitive verbs and relative clauses. In our investigation so far, we had no need for double adjoints, such as arise from Chomskian traces in English or from clitic pronouns in Romance languages, although they may still come up if the investigation is carried further. In the absence of double adjoints, our rudimentary pregroup grammar could have been replaced by the better established Ajdukiewicz grammar, as modified by Bar-Hillel and supplemented by an ordered set of basic types, richer than the usual set \{S, N\}.

REFERENCES


2. R. Baalbaki, Teaching Arabic at University level, problems of grammatical tradition, Proceedings of the colloquium on Arabic linguistics, Univ. of Bucharest, 1995.


5. C. Casadio and J. Lambek, An algebraic analysis of clitic pronouns in Italian, see [3], 116-124.


FOOTNOTES

1) For readers interested in the theoretical background, the notion of a pregroup also requires expansions $1 \rightarrow a a^\ell$ and $1 \rightarrow a^r a$. But, as was shown in [8], these can be dispensed with, as long as we are only concerned with sentence verification.

2) It may also have type $\pi_i^r s_j$ in so-called “nominal” sentences, where $\pi_i$ is the type of the $i$-th person subject. However, we will ignore nominal sentences in this paper.

3) The Arab philosopher al-Kindi [7] proposed the verb $V_3 = (', (y), s, -, a)$ as a back formation from $V_2$ to render the verb “to be” in the present tense.

4) Our rule (W1) in [4] needs two corrections:
   (1) When $Y = w$ or $y$ and $V' \neq a$, we wrongly asserted that
   $$V(Y)V' \rightarrow V' \text{ before } CV''V''.$$  
   This should be corrected to say that
   $$V(Y)V' \rightarrow VV \text{ before } CV''V''.$$  
   (2) We also implied that
   $$a(Y)a \rightarrow aa \text{ before } CV''.$$
   The auxiliary verb laiisa contradicts this and suggests instead
   $$a(Y)a \rightarrow aYY \text{ before } CV''.$$  

5) In this paper we shall ignore the dual $(n = 2)$. 