Subject-Verb Agreement in Modern Standard Arabic
An LFG Implementation in the Xerox Language Engineering Environment

Frederick Hoyt
University of Texas at Austin

Abstract

This report descibes a grammar for modelling the morphosyntax of verbal agreement in Modern Standard Arabic (MSA). The grammar is implemented in the Xerox Language Engineering (XLE) environment, which is based on the Lexical Functional Grammar framework. MSA has a complex verbal agreement system which defies being modelled in terms of constraints on a single formal representation. Instead, the complexities of agreement in MSA are best decribed as two agreement systems, each of which requires its own constraints; the interaction of these produces the complexities in the data. The XLE architecture allows different grammatical representations to be used, each of which is subject to different constraints. Use of XLE therefore allows the agreement facts in MSA to be modelled in a compactly modular grammar which generates a low number of ambiguities in parsing.

1 Verbal Agreement Marking in MSA

Arabic verbs are richly inflected and show marking for number (singular, plural, dual), gender (masculine, feminine), and person (1st, 2nd, 3rd), as well as for mood (which will not be addressed here). I refer to number, gender, and person features collectively as *agreement-* or *AGR*-features.

MSA is a pro-drop language, meaning that verbal agreement morphemes can be interpreted as "pronouns." The first and second person agreement forms are always pronominal in this sense, as are all plural agreement forms. This means that an independent NP corresponding to the subject can only appear with pronominal agreement if the NP is interpreted as a *discourse function*, in particular as a FOCUS rather than as the subject. However, in the 3rd-person-singular, independent subject NPs can also be used with the verb, in which case the agreement marking simply "matches" some subset of the subject's AGR-features (Fassi-Fehri, 1988).

1.1 Agreement and word order

If a sentence contains a singleton subject NP, how the verb is marked for agreement depends on the word order of the subject relative to the verb. In VS order the verb agrees with the subject only in gender and is marked in the singular, whether the subject is singular (1) or plural (2). Plural marking on the verb is only acceptable if the NP is interpreted with contrastive focus, and hence in LFG terms as a *discourse function* rather than as a SUBJ (3):

(1)   **kætaba**   l-waladu l-wæːǧıba.
       wrote.prf.3MS the-boy   the-paper
       "The boy wrote the paper."

(2)   **kætaba**   l-awlæːdu   l-wæːǧıba.
       wrote.3MS the-boys.MP the-paper
       "The boys wrote the paper."

(3)   **kætabu**   l-awlæːdu   l-wæːǧıba   (wa-læː
       wrote.3MP the-boys.MP the-assignment   and-not
       ıl-bænæːtu   ).
       the-girls.FS
       "The BOYS wrote the homework (and not the girls)."

In SV word order the verb agrees with the subject NP in gender and number. If the subject is singular, the verb is marked as singular (4); if the subject is plural, the verb must be marked as plural (5); singular marking is unacceptable (6):

(4) ʔal-waladu **kætaba** l-wæːǧıba.
the-boy wrote.prf.3MS the-paper
"The boy wrote the paper."

(5) ʔal-awlæːdu **kætabu** l-wæːǧıba.
the-boys.MP wrote.3MP the-paper
"The boys wrote the paper."

(6) * ʔal-awlæːdu **kætaba** l-wæːǧıba.
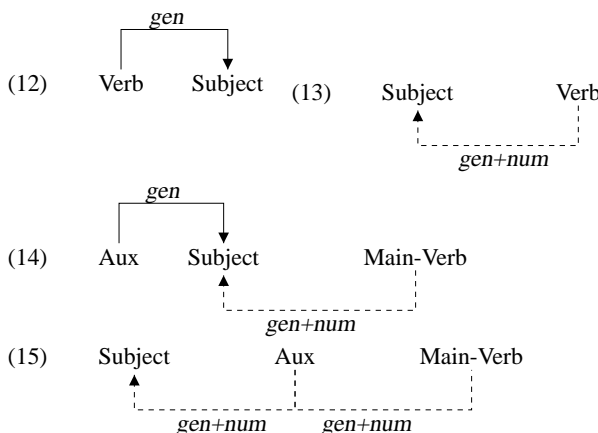the-boys.MP wrote.3MS the-paper
"Same."

In sentences with an initial auxiliary verb both the VS and the SV rules apply. In Aux-S-V word order, the auxiliary agrees only in gender while the main verb agrees in both gender and number:

(7) **kæːnat** ıl-bıntu **taktubu** l-wæːǧıba.
was.3FS the-girl.FS write.3FS the-paper
"The girl was writing the paper."

(8) **kæːnat** ıl-bænæːtu **yaktʊbna** l-wæːǧıba.
was.3FS the-girl.FP write.3FP the-paper
"The girls were writing the assingment."

If the subject precedes the auxiliary, then both verbs agree with it in both gender and number:

(9) ʔal-bıntu **kæːnat taktubu** l-wæːǧıba.
the-girl.FS was.3FS write.3FS the-paper
"Same."

(10) ʔal-bænæːtu **kʊnna yaktʊbna** l-wæːǧıba.
the-girls.FP were.3FP write.3FP the-paper
"Same."

(11) * ʔal-bænæːtu **kæːnɛt yaktʊbna** l-wæːǧıba.
the-girls.FP be.3FS write.3FP the-paper
"Same."

The agreement patterns in VS vs. SV word order are summarized in the following diagrams:

(12) [gen diagram] Verb → Subject

(13) Subject ← Verb [gen+num]

(14) [gen diagram] Aux → Subject Main-Verb [gen+num]

(15) Subject Aux Main-Verb [gen+num] [gen+num]

1.2 Agreement with Conjoined Subjects

Agreement marking is further complicated with subjects consisting of conjoined NPs. In VS word order, the verb agrees only with the first conjunct (16). As before, if the verb has non-singular agreement marking then the conjoined NP must interpreted as a FOCUS rather than as a subject:

(16) **kætabat** ıl-bıntu wa-l-waladu l-wæːǧıba.
wrote.3FS the-girl.FS and-the-boy.MS the-paper
"The girl and the boy wrote the paper."

(17) **kætabæː** ıl-bıntu wa-l-waladu
wrote.3DL the-girl.FS and-the-boy.MS
l-wæːǧıba (wa-læː ʔana).
the-assignment and-not I
"The GIRL AND THE BOY wrote the paper (and not me)."

As before, the verb agrees with a plural first conjunct only in gender:

(18) **kætaba** l-awlæːdu wa-l-banæːtu
wrote.3MS the-boys.MS and-the-girls.FS
l-wæːǧıba.
the-paper
"The boys and the girls wrote the paper."

(19) **kætabat** ıl-banæːtu wa-l-awæːdu l-wæːǧıba.
wrote.3FS the-boys.MS and-the-girls.FP the-paper
"The girls and the boys wrote the paper."

In sentences with SV word order, the verb agrees with the whole conjoined subject rather than just one of its conjuncts. The gender of the whole conjoined NP is masculine (20) unless both conjuncts are feminine nouns (22):

(20) ʔal-bıntu wa-l-waladu kætabæː l-wæːǧıba.
the-girls.FS and-the-boy.MS wrote.3MD the-paper
"The girl and the boy wrote the paper."

(21) * ʔal-bıntu wa-l-waladu kætabatæː l-wæːǧıba.
the-girls.FS and-the-boy.MS wrote.3FD the-paper
"The girl and the boy wrote the paper."

(22) ʔal-bıntu wa-ʔʊmmu-hæ kætabatæː
the-girl.FS and-mother.FS-nom-cl3FS wrote.3FD
l-wæːǧıba.
the-paper
"The girl and her mother wrote the paper."

(23) * ʔal-bıntu wa-ʔʊmmu-hæ kætabæː
the-girl.FS and-mother.FS-nom-cl3FS wrote.3MD
l-wæːǧıba.
the-paper
"The girl and her mother wrote the paper."

Likewise, the number value of the whole conjoined NP will be plural unless both conjuncts are singular, in which case the whole NP is dual (26):

(24) l-banæ:tu wa-l-awæ:du kætabu
the-girls.FS and-the-boys.MS wrote.3MP
l-wæ:ǧıba.
the-paper
"The girls and the boys wrote the paper."

(25) ʔal-bænæ:tu wa-l-awlæ:du kætabæ:
the-girls.FP and-the-boys.MP wrote.3MD
l-wæ:ǧıba.
the-paper
"Same."

(26) ʔal-bıntu wa-l-waladu kætabæ: l-wæ:ǧıba.
the-girl.FS and-the-boy.MS wrote.3MD the-paper
"The girl and the boy wrote the paper."

(27) * ʔal-bıntu wa-l-waladu kætabu l-wæ:ǧıba.
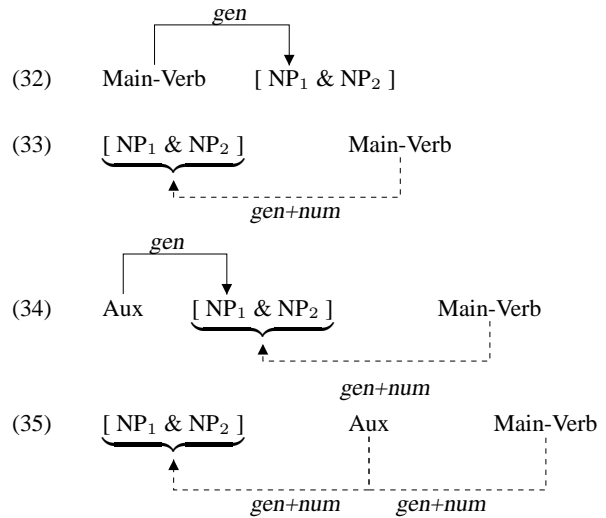the-girl.FS and-the-boy.MS wrote.3MP the-paper
"Same."

In Aux-S-V order, the auxiliary agrees with the first conjunct, while the main verb agrees with the whole conjoined NP. This creates striking mismatches in the agreement marking between the auxiliary in the main verb. For example, in (28, 29) the auxiliary is in the feminine singular, agreeing with the first conjunct while the main verb is in the masculine dual (28) or plural (29), dependening on whether the two conjoined nouns are singular or plural:

(28) **kænæt** ıl-bıntu wa-l-waladu **yaktʊbæ:**
was.3FS the-girl.FS and-the-boy.MS write.3DL
l-wæ:ǧıba.
the-paper
"The girl and the boy were writing the paper."

(29) **kæ:næt** ıl-banæ:tu wa-l-awlæ:du
was.3FS the-girls.3FS and-the-boys.MP
yaktubu:na l-wæ:ǧıba.
write.3MP the-paper
"The girls and the boys were writing the assingment."

In S-Aux-V word order, the auxiliary and main verb agree with the conjoined NP in number and gender:

(30) ıl-bıntu wa-l-waladu **kænæ: yaktʊbæ:**
the-girl.FS and-the-boy.MS was.3FS write.3DL
l-wæ:ǧıba.
the-paper
"The girl and the boy were writing the paper."

(31) * ıl-banæ:tu wa-l-awlæ:du **kæ:næt**
the-girls.3FS and-the-boys.MP was.3FS
yaktubu:na l-wæ:ǧıba.
write.3MP the-paper
"The girls and the boys were writing the assingment."

The agreement patterns for conjoined subject NPs are summarized in the following schemata:

(32) Main-Verb [NP₁ & NP₂]
gen

(33) [NP₁ & NP₂] Main-Verb
gen+num

(34) Aux [NP₁ & NP₂] Main-Verb
gen *gen+num*

(35) [NP₁ & NP₂] Aux Main-Verb
gen+num *gen+num*

1.3 SV Agreement and Anaphoric Agreement

The agreement marking patterns seen in the SV word orders are identical to patterns in agreement between anaphoric pronouns and their antecendents. In particular, anaphoric pronouns agree with their antecendents in gender, person, and number:

(36) **ǧiræ:n**-na, raʔaytu-**hʊm** yašrabu:na
neighbors.MP-cl1P saw.1S-cl3MP drink.3MP
l-hæšiš.
the-hashish
"Our neighbors, I saw them smoking hashish."

(37) * **ǧiræ:n**-na, raʔaytu-**hu** yašrabu:na
neighbors.MP-cl1P saw.1S-cl3MS drink.3MP
l-hæšiš.
the-hashish
"Same."

If the antecedent is a conjoined NP, the same gender and number resolution rules apply as in agreement marking with pre-verbal conjoined subjects:

(38) ʔabu:-y wa-ʔʊmm-i, hʊmmæ: mın
father.MS-cl1S and-mother.FS-cl1S pro.3MD from
aṣli ʕarabi:.
origin.MS-gen Arab.MS-gen
"My father and my mother are of Arab origin."

(39) * ʔabu:-y wa-ʔʊmm-i, hu mın
father.MS-cl1S and-mother.FS-cl1S pro.3MS from
aṣli ʕarabi:.
origin.MS-gen Arab.MS-gen
"Same."

This suggests that the dependency between pre-verbal subjects and the agreement marking on the verb is similar to the dependency between an anaphoric pronoun and its antecedent, and therefore that it is a *semantic* dependency.

1.4 Discussion

The data reviewed above suggest the following descriptive generalizations for verbal agreement marking in Standard Arabic:

(40) Standard Arabic has two kinds of agreement:

    a. *Grammatical agreement*: agreement marking constraining the *form* of the subject of the verb.

    b. *Semantic agreement*: agreement marking constraining the *interpretation* of the subject.

(41) Agreement type is determined by word order:

    a. Grammatical agreement obtains in VS order or any verb stem - subject pair;

    b. Semantic agreement obtains in SV word order as well as in antecedent-pronoun binding.

These pose two problems for a syntactic theory which views the agreement relation as a simple matter of feature unification between two sets of features, one specified on the verb and the other on the subject NP. The first problem is that the agreement marking for a given verb stem seems to license nouns in one position more restrictively than it does in others. The second problem is that two verb stems can occur in the same clause and agree with the same subject but show different agreement markings.

2 Analysis and Implementation

In LFG terms, grammatical agreement is represented as a set of constraints on the different *projections* of a sentence. The solution I propose uses two projections from C-structure: the standard f-structure as well as an additional *s-structure* projection (for "semantic structure") which is projected from f-structure (Wechsler & Zlatic, 2003):
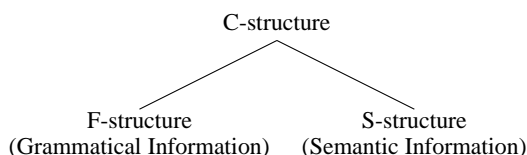

Grammatical agreement is represented as a set of constraints on the f-structure of the sentence, while semantic agreement is represented as constraints on its s-structure:

(42) *Grammatical Agreement*: Constraints on F-structures

    a. Verbal agreement marking imposes constraints on the subject function of the clause;

    b. Constrains only the subject's gender feature.

(43) *Semantic Agreement*: Constraints on Interpretation

    a. Verbal agreement marking constrains the interpretation of the subject;

    b. Constrains person, gender, and number.

For example, the sentence in (44) has the syntactic structure in (45):

(44) kætabat   ıl-bænæːtu   l-wæːğıba.
wrote.3FS the-girls.3FS the-paper

"The girls wrote the paper."

(45)
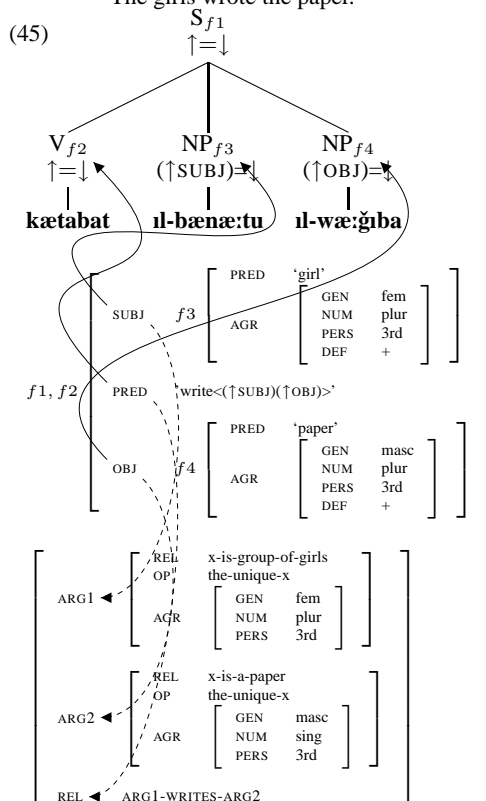
2.1 Agreement with singleton subject NPs

Agreement in VS word order is expressed with f-structure constraints. These are implemented as lexical templates which are included in the verb lexical entries. Verb stems marked in the 1st- and 3rd-persons as well as all plural verbs have "pronominal agreement marking," meaning that they are lexically specified with a lexical template which introduces a pronominal subject at f-structure:

```
(46) ProAgr = (^ SUBJ PRED)= 'pro'
              (^ SUBJ PRON)= pers
              (s::^ ARG1 AGR) = (^SUBJ AGR)
              (s::^ ARG1 REL) = 'pro'.
```

This constraint optionally introduces an s-structure pronoun and identifies the AGR-features of the f-structure SUBJ function with the AGR-feature of the s-structure argument. For example, the sentence in (47) has the f-structure in (48) and the s-structure in (49):

(47) kætabu   l-wæːǧıba.
     wrote.3MP the-assignment
     "They [masc] wrote the paper."

(48) *f-structure*:

```
"katabu il-waajiba"
        ┌PRED   'write<[0-SUBJ:pro], [3:assignment]>'        ┐
        │       ┌PRED 'pro'                           ┐      │
        │SUBJ   │AGR  [GEN masc, NUM plur, PERS 3rd]  │      │
        │       └CASE nom, PRON pers                  ┘      │
        │       ┌PRED 'assignment'                          ┐│
       0│       │AGR  [ANIM -, GEN masc, NUM sing, PERS 3rd]││
       1│OBJ   3│CASE acc, DEF +                            ┘│
      11│                                                     │
      17└ASPECT Perfect                                       ┘
```

(49) *s-structure*:

```
        ┌     ┌AGR [GEN masc, NUM plur, PERS 3rd]┐       ┐
        │ARG1 │REL 'pro'                         │       │
        │     └                                  ┘       │
       0│     ┌AGR [GEN masc, NUM sing, PERS 3rd]       ┐│
       1│ARG2 2│                                         ││
      12│     3└OP 'the-unique-x', REL 'x-is-an-assignment'┘│
      18└REL   'ARG1-write-ARG2'                           ┘
```

The agreement marking on the verb introduces a "pro" subject specified with 3rd-masculine-plural AGR-features. This pronominal subject projects an s-structure ARG1 function with which it shares identical AGR-features. The pronominal feature specification precludes the addition of an independent subject NP because such an NP would fail to satisfy the *coherency* condition. Instead, the independent NP must be interpreted as a FOCUS:

(50) kætabu   l-awlæːdu   l-wæːǧıba.
     wrote.3MP the-boys.MP the-paper
     "The BOYS wrote the paper."

(51) *f-structure*:

```
"katabu il-awlaadu il-waajiba"
        ┌PRED   'write<[0-SUBJ:pro], [5:assignment]>'       ┐
        │       ┌PRED 'pro'                           ┐     │
        │SUBJ   │AGR  [GEN masc, NUM plur, PERS 3rd]  │     │
        │       └CASE nom, PRON pers                  ┘     │
        │       ┌PRED 'assignment'                          ┐│
        │OBJ   5│AGR  [ANIM -, GEN masc, NUM sing, PERS 3rd]││
        │       └CASE acc, DEF +                            ┘│
        │       ┌PRED 'boy'                                 ┐│
       0│FOCUS  │AGR  [ANIM +, GEN masc, NUM plur, PERS 3rd]││
       1│      3│CASE nom, DEF +                            ┘│
      19│                                                    │
      25└ASPECT Perfect                                      ┘
```

(52) *s-structure*:

```
        ┌     ┌AGR [GEN masc, NUM plur, PERS 3rd]        ┐  ┐
        │ARG1 3│                                          │  │
        │     2└OP 'the-unique-x', REL 'x-are-boys'       ┘  │
       0│     ┌AGR [GEN masc, NUM sing, PERS 3rd]            ┐│
       1│ARG2 4│                                             ││
      20│     5└OP 'the-unique-x', REL 'x-is-an-assignment'  ┘│
      25└REL   'ARG1-write-ARG2'                             ┘
```

3rd-person-singular verbs have a special disjunctive lexical template for agreement features:

(53) `3rdSingSubj( _G ) = {[@ProAgr`
     `                     @(3rdSing _G )]`
     `                     |`
     `                     @(GramAgr _G )}.`

For example, the perfect stem **kætaba** "(he) wrote" would include the following:

(54) `kataba V * @(TransPerf write)`
     `            @(3rdSingSubj masc).`

The first conjunct specified semantic agreement constraints as above, while the second conjunct specifies grammatical agreement:

(55) `GramAgr( _G ) = (^SUBJ AGR GEN) =c _G`
     `                @(PersAgr 3rd ).`

This template introduces a *constraining equation* which requires the value of the f-structure SUBJ gender feature to match that of the argument of the template. For this constraint to be satisfied, an independent NP will have to provide a gender feature with the appropriate value. The only other mechanism in the grammar which can introduce an independent subject NP is the following rule:

(56) `S  --> [V: ^=! ]`
     `       [([NP: (^SUBJ)=!]),`
     `        ([NP: (^OBJ)=!]),`
     `        ([NP: (^FOCUS)=!`
     `         (^GF) = %f2`
     `         [s::%f2 = s::(^FOCUS)]])]`
     `       [([VP: (^COMP)=!])].`

The interaction of the constraining equation above and this rule guarantees that grammatical agreement will occur between the subject and verb only in VS word order. For example, the sentence in (57) has the f- and s-structures in (57a-b), in which the agreement marking on the verb introduces no information into the representation because it only constrains the gender feature of the subject:

(57) kætabat   ıl-bænæːtu   l-wæːǧıba.
     wrote.3F the-girls.FS the-paper
     "The girls wrote the paper."

(58) *f-structure*:

```
"katabat il-banaatu il-waajiba"
        ┌PRED   'write<[3:girl], [5:assignment]>'          ┐
        │       ┌PRED 'girl'                              ┐│
        │SUBJ   │AGR  [ANIM +, GEN fem, NUM plur, PERS 3rd]││
        │      3└CASE nom, DEF +                           ┘│
        │       ┌PRED 'assignment'                         ┐│
       0│OBJ    │AGR  [ANIM -, GEN masc, NUM sing, PERS 3rd]││
      19│      5└CASE acc, DEF +                            ┘│
      25└ASPECT Perfect                                      ┘
```

(59) *s-structure*:

```
       2┌     ┌AGR [GEN fem, NUM plur, PERS 3rd]         ┐ ┐
       3│ARG1 0│                                          │ │
        │     1└OP 'the-unique-x', REL 'x-are-girls'      ┘ │
      18│     ┌AGR [GEN masc, NUM sing, PERS 3rd]           ┐│
      24│ARG2 4│                                            ││
      25│     5└OP 'the-unique-x', REL 'x-is-an-assignment' ┘│
      26└REL   'ARG1-write-ARG2'                            ┘
```

Agreement in SV word order is expressed with s-structure constraints which identify the pre-verbal NP with a pronominal subject introduced by the @ProAgr template. S-structure identification entails that AGR-features of the preverbal subject match those of the pronominal subject. This enforces full agreement in gender and number.

(60) ```
IP --> [NP: (^ TOPIC) = !]
       I': ^=!.
```

(61) ```
I' --> [e:
        (^GF) = %f1
        [s::%f1 = s::(^TOPIC)]
        (^TOPIC CASE) = Nom]
       [S: ^=!].

    GF = {SUBJ|OBJ}.
```

According to these rules, NPs in the preverbal position are TOPICS rather than subjects — in other words, SV or S-Aux-V word order should really be called Top-V or Top-Aux-V word-order. The TOPIC is identified in s-structure with the subject of the clause. For example, the sentence in (62) has the f- and s-structure representations in (62a-b):

(62) ?al-awlæːdu kætabu   l-wæːǧıba.
      the-boys.MP wrote.3MP the-paper
      "The boys wrote the paper."

(63) *f-structure*:

```
"il-awlaadu katabu il-waajiba"

    ⎡PRED   'write<[2-SUBJ:pro], [5:assignment]>'              ⎤
    ⎢       ⎡PRED 'pro'                                 ⎤      ⎥
    ⎢SUBJ   ⎢AGR  [GEN masc, NUM plur, PERS 3rd]        ⎥      ⎥
    ⎢       ⎣CASE nom, PRON pers                        ⎦      ⎥
    ⎢       ⎡PRED 'assignment'                          ⎤      ⎥
    ⎢OBJ    ⎢AGR  [ANIM -, GEN masc, NUM sing, PERS 3rd]⎥      ⎥
    ⎢     5 ⎣CASE acc, DEF +                            ⎦      ⎥
    ⎢  2                                                       ⎥
    ⎢  3    ⎡PRED 'boy'                                 ⎤      ⎥
    ⎢ 17 TOPIC AGR [ANIM +, GEN masc, NUM plur, PERS 3rd]     ⎥
    ⎢ 24    ⎣                                           ⎦      ⎥
    ⎢ 25  1 CASE nom, DEF +                                    ⎥
    ⎣ 26 ASPECT Perfect                                        ⎦
```

(64) *s-structure*:

```
  2 ⎡ARG1 0 ⎡AGR [GEN masc, NUM plur, PERS 3rd]        ⎤ ⎤
  3 ⎢       1 ⎣OP 'the-unique-x', REL 'x-are-boys'     ⎦ ⎥
 18 ⎢                                                    ⎥
 24 ⎢ARG2 4 ⎡AGR [GEN masc, NUM sing, PERS 3rd]        ⎤ ⎥
 25 ⎢       5 ⎣OP 'the-unique-x', REL 'x-is-an-assignment'⎦⎥
 26 ⎣REL   'ARG1-write-ARG2'                             ⎦
```

In clauses with auxiliaries, agreement between the subject and main verb is represented as an *anaphoric control* relation. Auxiliary verbs select a complement, and then assert s-structure identity between their subjects and the subjects of their complements:

(65) ```
kaana V * @(RaisePerf be)
          @(3rdSingSubj Masc)
          @KHS.
```

(66) ```
RaisePerf(_PRED) = @(RaiseVerb _PRED)
                   @Perf.
```

(67) ```
RaiseVerb(_PRED) =
    (^PRED) = '_PRED<(^COMP)>(^SUBJ)'
    s::(^SUBJ) = s::(^COMP SUBJ)
    s::^ = s::(^COMP).
```

This is similar to the annotation used in the I'-rule, except that instead of asserting s-structure identity between the topic and subject of one clause, it asserts s-structure identity between the subject of the

auxiliary and the subject of the complement. As before, s-structure identity implies identity of AGR-features, capturing full agreement between the subject and the verb. For example, the sentence in (68) has the f- and s-structures in (68a-b):

(68)  kæːna      l-awlæːdu   yaktʊbuːna l-wæːǧıba.
      was.3MS the-boys.MP write.3MP the-paper
      "The boys were writing the paper."

(69)  *f-structure*:

```
"kaana il-awlaadu yaktubuuna il-waajiba"

⎡PRED   'be<[4:write]>[3:boy]'                                  ⎤
⎢       ⎡PRED 'boy'                                    ⎤        ⎥
⎢SUBJ   ⎢AGR  [ANIM +, GEN masc, NUM plur, PERS 3rd]   ⎥        ⎥
⎢     3 ⎣CASE nom, DEF +                               ⎦        ⎥
⎢       ⎡PRED 'write<[4-SUBJ:pro], [7:assignment]>'    ⎤        ⎥
⎢       ⎢      ⎡PRED 'pro'                        ⎤     ⎥        ⎥
⎢       ⎢SUBJ  ⎢AGR [GEN masc, NUM plur, PERS 3rd]⎥     ⎥        ⎥
⎢       ⎢      ⎣CASE nom, PRON pers               ⎦     ⎥        ⎥
⎢COMP   ⎢      ⎡PRED 'assignment'                 ⎤     ⎥        ⎥
⎢  0    ⎢OBJ   ⎢AGR [ANIM -, GEN masc, NUM sing, PERS 3rd]⎥     ⎥
⎢  1    ⎢    5 ⎣7 CASE acc, DEF +                  ⎦     ⎥        ⎥
⎢  4 26 25 ASPECT Imperfect, CASE Acc                           ⎥
⎣ 29 ASPECT Perfect                                             ⎦
```

(70) *s-structure*:

```
  4 ⎡ARG1 2 ⎡AGR [GEN masc, NUM plur, PERS 3rd]        ⎤ ⎤
  5 ⎢       3 ⎣OP 'the-unique-x', REL 'x-are-boys'     ⎦ ⎥
 25 ⎢                                                    ⎥
  0 ⎢ARG2 6 ⎡AGR [GEN masc, NUM sing, PERS 3rd]        ⎤ ⎥
  1 ⎢       7 ⎣OP 'the-unique-x', REL 'x-is-an-assignment'⎦⎥
 26 ⎢                                                    ⎥
 27 ⎣REL   'ARG1-write-ARG2'                             ⎦
```

Agreement in S-Aux-V word involves two anaphoric control equations. The pre-verbal subject is interpreted as a TOPIC function, the s-structure projection of which is identified with the s-structure projection of the subjects of the auxiliary and the main verb:

(71) ?al-awlæːdu kæːnu   yaktʊbuːna l-wæːǧıba.
      the-boys.MP were.3MP write.3MP the-paper
      "The boys were writing the paper."

(72) *f-structure*:

```
"il-awlaadu kaanu yaktubuuna il-waajiba"

⎡PRED   'be<[4:write]>[2-SUBJ:pro]'                             ⎤
⎢       ⎡PRED 'pro'                                    ⎤        ⎥
⎢SUBJ   ⎢AGR  [GEN masc, NUM plur, PERS 3rd]           ⎥        ⎥
⎢       ⎣PRON pers                                     ⎦        ⎥
⎢       ⎡PRED 'boy'                                    ⎤        ⎥
⎢TOPIC  ⎢AGR  [ANIM +, GEN masc, NUM plur, PERS 3rd]   ⎥        ⎥
⎢     1 ⎣CASE nom, DEF +                               ⎦        ⎥
⎢       ⎡PRED 'write<[4-SUBJ:pro], [7:assignment]>'    ⎤        ⎥
⎢       ⎢      ⎡PRED 'pro'                        ⎤     ⎥        ⎥
⎢       ⎢SUBJ  ⎢AGR [2-SUBJ-AGR]                  ⎥     ⎥        ⎥
⎢  2    ⎢      ⎣CASE nom, PRON pers               ⎦     ⎥        ⎥
⎢COMP   ⎢      ⎡PRED 'assignment'                 ⎤     ⎥        ⎥
⎢  3    ⎢OBJ   ⎢AGR [ANIM -, GEN masc, NUM sing, PERS 3rd]⎥     ⎥
⎢ 24    ⎢    5 ⎣7 CASE acc, DEF +                  ⎦     ⎥        ⎥
⎢ 27 28 23 ASPECT Imperfect, CASE Acc                           ⎥
⎣ 29 ASPECT Perfect                                             ⎦
```

(73) *s-structure*:

```
  4 ⎡ARG1 0 ⎡AGR [GEN masc, NUM plur, PERS 3rd]        ⎤ ⎤
  3 ⎢       1 ⎣OP 'the-unique-x', REL 'x-are-boys'     ⎦ ⎥
 23 ⎢                                                    ⎥
  2 ⎢ARG2 6 ⎡AGR [GEN masc, NUM sing, PERS 3rd]        ⎤ ⎥
  3 ⎢       7 ⎣OP 'the-unique-x', REL 'x-is-an-assignment'⎦⎥
 24 ⎢                                                    ⎥
 25 ⎢REL   'ARG1-write-ARG2'                             ⎥
 26 ⎢                                                    ⎥
 27 ⎣                                                    ⎦
```

2.2 Agreement with conjoined NPs

Turning to conjoined subjects, in VS word order with a conjoined subject NP the first conjunct is the

"head" of the NP while the conjunction and second conjunct form a constituent which is adjoined to the first conjunct:

```
(74)  NP      -->     [NP: ^=!
                           s::! = s::^]
                      [ConjP: ! $ (^ADJ)
                              s::! = s::^].
(75)  ConjP   -->     [Conj: ^=!]
                      [NP: !=^].
```

The whole conjoined NP will inherit the f-structure features of its first conjunct, so that in VS word order, the verb agrees with the first conjunct. The s-structure relation (REL) feature for the conjoined NP is represented as a predicate which takes the two conjuncts and returns a set containing them. REL features for NP s-projections are determined by (76):

```
(76)  RelCalc =
      {[s::! = s::^
       ~(ADJ^)
       ~(^ADJ)]
       |
       [s::! $ (s::^ CONJ)
       (s::^ REL) = 'all-x-in-CONJ'
       (ADJ^)]
       |
       [s::! $ (s::^ CONJ)
       (^ADJ)]}.
```

The s-structure gender and number features of the conjoined NP are resolved according to pragmatic principles which err in favor of masculine gender and plural number. A conjoined NP is masculine unless both conjuncts are feminine, and plural unless both conjuncts are singular. This is represented by the following lexical templates:

```
(77)  GenCalc =
      {[(^AGR GEN) = (s::^ AGR GEN)]
       |
       [(s::^ AGR GEN) = Masc
       (^AGR GEN) ~= ((ADJ ^) AGR GEN)
       (ADJ^)]
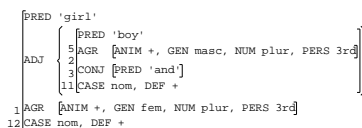       |
       [(s::^ AGR GEN) = Masc
       (^ADJ)]}.
(78)  NumCalc =
      {[(s::^ AGR NUM) = (^AGR NUM)
       ~(ADJ ^)
       ~(^ADJ)]
       |
       [(s::^ AGR NUM) ~= Sing
       (^ADJ)]
       |
       [(s::^ AGR NUM) = Plur
      {[((ADJ ^) AGR NUM) ~= Sing]
       |
```

```
      [(^AGR NUM) ~= Sing]}]
       |
       [(s::^ AGR NUM) = Dual
      ((ADJ ^) AGR NUM) =c Sing
      (^AGR NUM) =c Sing]}.
```

As an example, the conjoined NP in (79) has the grammatical structure in structure in (80-82):

(79) ?al-bænæ:tu wa-l-awlæ:du
the-girls.FP and-the-boys.MP

"the girls and the boys"

(80) *f-structure*:

(81) *s-structure*:

(82) *c-structure*:

Reversing the order of the conjuncts changes the c-structure (86) and f-structure (84), but produces an s-structure (85) identical to the one in (81):

(83) ?al-bænæ:tu wa-l-awlæ:du
the-girls.FP and-the-boys.MP

"the girls and the boys"

(84) *f-structure*:

(85) *s-structure*:

(86) *c-structure*:

Agreement with conjoined NPs in VS word order works according to the same constraints as described above for singleton NPs. Because the first conjunct

defines the f-structure AGR-feature of the whole conjoined NP, grammatical agreement for conjoined NPs in VS word order works in exactly the same fashion as it does for singleton NPs. In the interest of space, examples will not be provided.

In SV order agreement is as before except that s-structure AGR features for the subject are calculated according to (77) and (78). This means that (87) and (88) will have an identical f-structure for their s-nodes (89) and will share the s-structure in (90):

(87)   ?al-alwæːdu wa-l-bænæːtu   kæːnu
        the-boys.MP and-the-girls.FP were.3MP
        yaktʊbuːna l-wæːǧɪba.
        write.3MP the-paper

        "The boys and the girls were writing the paper."

(88)   ?al-bænæːtu wa-l-alwæːdu   kæːnu
        the-girls.FP and-the-boys.MP were.3MP
        yaktʊbuːna l-wæːǧɪba.
        write.3MP the-paper

        "The girls and the boys were writing the paper."

(89)   *f-structure*:

$$
\begin{bmatrix}
\text{PRED} & \text{'be<[8:write]>[6-SUBJ:pro]'} \\
\text{SUBJ} & \begin{bmatrix} \text{PRED 'pro'} \\ \text{AGR [GEN masc, NUM plur, PERS 3rd]} \\ \text{PRON pers} \end{bmatrix} \\
\text{COMP} & \begin{bmatrix} \text{PRED 'write<[8-SUBJ:pro], [11:assignment]>'} \\ \text{SUBJ} \begin{bmatrix} \text{PRED 'pro'} \\ \text{AGR [6-SUBJ-AGR]} \\ \text{CASE nom, PRON pers} \end{bmatrix} \\ \text{OBJ} \begin{bmatrix} \text{PRED 'assignment'} \\ \text{AGR [ANIM -, GEN masc, NUM sing, PERS 3rd]} \\ \text{CASE acc, DEF +} \end{bmatrix} \\ \text{ASPECT Imperfect, CASE Acc} \end{bmatrix} \\
\text{ASPECT Perfect}
\end{bmatrix}
$$

(90)   *s-structure*:

$$
\begin{bmatrix}
\text{ARG1} & \begin{bmatrix} \text{AGR [GEN masc, NUM plur, PERS 3rd]} \\ \text{CONJ} \begin{bmatrix} \text{OP 'the-unique-x', REL 'x-are-girls'} \\ \text{OP 'the-unique-x', REL 'x-are-boys'} \end{bmatrix} \\ \text{REL 'the-set-of-all-x-in-CONJ'} \end{bmatrix} \\
\text{ARG2} & \begin{bmatrix} \text{AGR [GEN masc, NUM sing, PERS 3rd]} \\ \text{OP 'the-unique-x', REL 'x-is-an-assignment'} \end{bmatrix} \\
\text{REL} & \text{'ARG1-write-ARG2'}
\end{bmatrix}
$$

This uniformity of s-structure representations might provide a means to extract propositional information from parsed text in spite of the variability in word order and agreement marking.

3   Summary and Conclusion

The grammar developed here captures the agreement facts described in Section 1, accepting the acceptable sentences and excluding the unacceptable ones. Furthermore, it does so while generating, at the most, four 4 ambiguous parses for test sentences, and in most cases generating only one parse. This result is based on a test-suite containing all the logical permutations of subject-verb relationships, including plural and conjoined nouns.

The analysis suggests that MSA uses f-structure more as a means to constrain c-structural relation-ships, leaving unification to take place at s-structure. To put it differently, s-structure is a grammatical representation, rather than simply a place-holder for a semantic representation. Sentences which are equivalent in terms of the number and AGR-values of their noun phrases but which vary in terms of word order produce identical s-structures, even though they produce distinct f- and c-structures. For example, the sentences (91-94) each have different agreement markings for the left-most verb stem and accordingly have distinct f- and c-structures. However, they share the s-structure in (95):

(91)   kætabat   ɪl-bænæːtu l-wæːǧɪba.
        wrote.3FS the-girls.FP the-paper

        "The girls wrote the paper."

(92)   ?al-bænæːtu kætabna   l-wæːǧɪba.
        the-girl.FP   wrote.3FP the-paper

        "Same."

(93)   kæːnat   ɪl-bænæːtu yaktʊbna l-wæːǧɪba.
        was.3FS the-girl.FP write.3FP the-paper

        "The girls were writing the paper."

(94)   ?al-bænæːtu kʊnna   yaktʊbna l-wæːǧɪba.
        the-girls.FS were.3FP write.3FP the-paper

        "Same."

(95)   *s-structure*:

$$
\begin{bmatrix}
\text{ARG1} & \begin{bmatrix} \text{AGR [GEN fem, NUM plur, PERS 3rd]} \\ \text{OP 'the-unique-x', REL 'x-are-girls'} \end{bmatrix} \\
\text{ARG2} & \begin{bmatrix} \text{AGR [GEN masc, NUM sing, PERS 3rd]} \\ \text{OP 'the-unique-x', REL 'x-is-an-assignment'} \end{bmatrix} \\
\text{REL} & \text{'ARG1-write-ARG2'}
\end{bmatrix}
$$

The conclusion is that f-structure and s-structure are mutually constraining, just as f-structure and c-structure are.

References

Stephen Wechsler & Larisa Zlatic. 2003. *The Many Faces of Agreement*. CSLI (Stanford).

Abdelkader Fassi-Fehri. 1988. *Agreement in Arabic, Binding and Coherence*. in *Agreement in Natural Language: Approaches, Theories, Description*. C. Ferguson & M. Barlow. Prentice-Hall, Englewood Cliffs, N.J. pp.107-158.