

The Developmental Trajectory of Grammatical Gender: Evidence from Arabic

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1. Introduction and aim

Grammatical gender is a morphosyntactic nominal classification feature according to which the elements syntactically related to the noun take different forms. Thus, gender is an inherent feature of the noun itself that controls the forms of other elements such as articles, adjectives, and verbs. Grammatical gender tends to correlate with some properties of the noun itself. These properties can be of two sorts; semantic properties represented by the meaning or the referent of the noun and morphophonological properties represented by the form of the noun (Corbett, 1991).

It has been well-documented that when the information provided by the noun itself conflicts; i.e., the form of the noun suggests one gender while its meaning suggests another, children were found to be biased to rely more on the noun's form than on its meaning when attributing gender. Such behaviour predominates children's responses between the ages of three and up to twelve (Karmiloff-smith, 1979; Levy, 1983; Perez-Pereira, 1991; Gagliardi & Lidz, 2014; Culbertson et al., 2019). Though languages vary with regard to the predictivity of the morphophonological and semantic properties of the nouns, adults were found to rely more on the meaning of the nouns when determining their gender classes (Cain et al., 1987; Carroll, 1999). Which properties take precedence over the others is indeed language specific and to determine gender assignment in such cases, one needs to have access to the overall system of the language in question.

Syntactic agreement has a different status from the semantic and the morphophonological properties of the noun because it is the defining element of gender. Nonetheless, young children were found to also ignore this defining cue and rely on the shape of the noun to determine its gender (Karmiloff-smith, 1979; Perez-Pereira, 1991).

Yet, it is still not clear at what age children overcome the morphophonological bias and approximate an adult-like weighting of the morphophonological, semantic, and syntactic cues for grammatical gender classes as well as the way adults weigh syntactic agreement against semantic information.

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The current paper has two main aims. First it tries to uncover the developmental trajectory of grammatical gender taking into consideration both the properties of the noun itself (morphophonological and semantic) and the defining properties coming from syntactic agreement. While many studies have looked at the cues used by L1 learners/speakers when assigning gender to nouns, few take into account all types of cues and present a developmentally comprehensive picture of how the gender system develops until it reaches its end status. Perez-Pereira (1991) has a study design quite similar to the one used here, but the participants in his experiment were between 4 and 11 years only. Gagliardi & Lidz's (2014) experiment had participants of many age groups (4-7 years, 8-12 years, and adults), however syntactic information was not a variable in their experiment. Second, my study offers an experimental investigation of gender assignment in Arabic. Arabic is an interesting language for investigating grammatical gender. Besides the regularity and high predictivity of its gender system (as will be discussed in the following section), Arabic does not have indefinite articles or demonstratives that obligatorily co-occur with the nouns making it unlikely for prenominal structures to be rote-learned combination with the noun. There is evidence that article + noun combinations could be learned (memorized by rote) as unanalysable chunks (Arnon & Ramscar, 2012) and that children are sensitive to multiword combinations even before they start producing their first two-word utterances (Skarabela et al., 2021). For these reasons, studying Arabic where such possibilities are, to the possible extent, controlled for, provides an opportunity to test whether the findings from the other studied languages are generalizable to other languages or whether they were by-products of the specific structures of those languages.

2. Grammatical gender assignment in Arabic

Arabic has a two-gender system, with every noun being either masculine or feminine. Animate as well as inanimate nouns are assigned gender in Arabic. Masculine is the morphophonologically unmarked gender and therefore considered the default whereas feminine is the morphophonologically marked gender as the contrasts between masculine and feminine nouns in (1) illustrate. Feminine nouns usually end in one of the three feminine morphophonological endings *-at* as in the feminine examples in (1), *-aa* as in *saḥr-a* 'desert), and *-aa* as in *ḥalwaa* (sweet)¹.

¹ Those endings are replaced by a single feminine morpheme; i.e. /-a(h)/ in most Arabic dialects. In addition, *-a(t)* is more common than the other two endings and it is the ending found in the group of feminine nouns derived from their masculine counterparts by means of suffixation.

- (1) a. $\text{ṭabi:b} / \text{ṭabi:b-a(t)}$
 doctor / doctor-fem
 b. $\text{ṭa:lib} / \text{ṭa:lib-a(t)}$
 student / student-fem
 c. $\text{ka:tib} / \text{ka:tib-a(t)}$
 writer / writer-fem
 d. $\text{'ibn} / \text{'ibn-a(t)}$
 son / daughter

The main characteristics of the Arabic gender system can be summarized as follows (see also Fig.1);

- All human males are grammatically masculine,
- All human females are grammatically feminine,
- Almost all nonhumans that are morphophonologically marked (i.e., ending in *-a*) are grammatically feminine (99.8%), and
- A large majority (92.7%) of morphologically unmarked nouns (i.e., lacking *-a* ending) are masculine.

As Fig.1 illustrates, semantic and morphophonological properties of nouns in Arabic interact with each other in determining the different gender classes nouns belong to. One general principle that works perfectly with no exceptions in Arabic is that nouns that refer to male humans are grammatically masculine and nouns that refer to female humans are grammatically feminine. Epicene nouns such as *šaḥṣ* (person), *fard* (individual), and *'insa:n* (human-being) are not against this perfect correlation between natural gender and grammatical gender in Arabic because whenever those nouns are used in a context, they have generic meaning where the sex of the referent is not important.

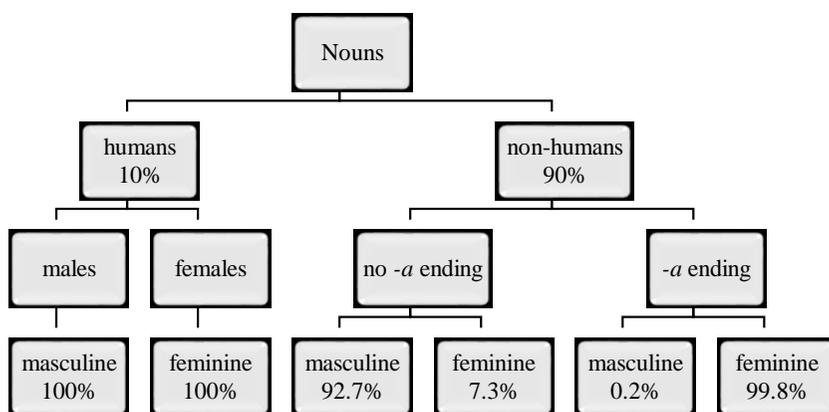


Fig.1. Gender classification in Arabic.

As stated above, another principle that accounts for the majority of the non-human nouns in Arabic is the correlation between the ending of the noun and its gender. When a noun ends in *-a*, it is more than 99% of the time feminine whereas when a noun lacks the *-a* ending, it is masculine more than 92% of the time.

Nonetheless, the way in which the semantic and the morphophonological principles interact is hierarchical; semantics always overrides morphophonology in Arabic as illustrated in Fig.1. The first step is to decide whether a given noun refers to a human or a nonhuman. Then, if it refers to a human, the biological sex of the referent will determine the grammatical gender of that noun no matter how it looks morphophonologically and this works with no exceptions. However, when the referent of the noun is non-human, its shape or morphophonology might determine its grammatical gender and might not. To put it differently, though *-a* is a morphophonological marker of feminine gender in Arabic (especially for non-humans), the absence of *-a* is not an indicator that the noun is grammatically masculine as there are some no *-a* ending nouns that are grammatically feminine in Arabic such as *yad* (hand), *na:r* (fire), and *šams* (sun). Those nouns are feminine despite that they lack the *-a* ending.

3. Method

3.1. Participants

The participants were 202 typically-developing Arabic speakers of five age groups. The youngest age group consisted of 7 toddlers (5 females) aged 2;6-3;11 (Mean age: 3;3). The second group consisted of 47 (29 females) pre-schoolers aged 4;0-5;11 (Mean age: 4;9). The third group consisted of 52 (35 females) school children aged 6;0-10;11 (Mean age: 8;2). The fourth group consisted of 45 (22 females) adolescents aged 11;0-15;11 (Mean age: 12;9). The last group consisted of 51 (26 females) adults aged 16 years and over (Mean age: 25;3).

Eighteen additional children (two 2-3, seven 4-5, nine 6-10), five adolescents, and four adults were tested but excluded from the final analyses due to failure to understand the task.

3.2. Materials

The verbal stimuli consisted of 24 novel nouns (table 1); which were created in accordance with Arabic phonotactics. The same nouns were used with *-a* ending and without *-a* ending to form two patterns; half of the participants had nouns (1-12) with *-a* and nouns (13-24) without *-a*, the other half of the participants had nouns (1-12) without *-a* and nouns (13-24) with *-a*. These nouns were assigned to the different cue combinations as explained in the next section. In addition to those nouns, the following two sentences were used to provide the subjects with the linguistic context containing syntactically agreeing elements. The demonstratives and adjectives are real Arabic words.

- ha:di X wa ha:di X ʔa:ny-a
this.F X and this.F X second-F
'This is X and this is a second X'
- ha:da X wa ha:da X ʔa:ni
this X and this X second
'This is X and this is a second X'

Table 1. List of novel nouns used in the main experiment

	-a ending novel Nouns	Non -a ending novel nouns
1	fadi:r-a	fadi:r
2	nu:ši-y-a	nu:ši
3	šandal-a	šandal
4	ǵa:diy-a	ǵa:di
5	daʼbu:s-a	daʼbu:s
6	šni:f-a	šni:f
7	laqi:m-a	laqi:m
8	šmi:l-a	šmi:l
9	zamma:l-a	zamma:l
10	šaḥru:r-a	šaḥru:r
11	za:š-a	za:š
12	fawa:n-a	faw:n
13	laʼbu:s-a	laʼbu:s
14	ḥatar-a	ḥatar
15	na:š-a	na:š
16	zʼi:f-a	zʼi:f
17	fali:l-a	fali:l
18	mandar-a	mandar
19	šbi:l-a	šbi:l
20	šbi:b-a	šbi:b
21	kammu:š-a	kammu:š
22	sabi:m-a	sabi:m
23	ǵa:dm-a	ǵa:dm
24	šli:w-a	šli:w

In addition to the verbal stimuli, 24 pairs of 3D characters of two different colours² or sizes, which either have indications as being male/female humans or nonhumans were created. Eight characters represented male-like humans (having moustaches and/or short hair), 8 represented female-like humans (wearing dresses, skirts, having long hair or bows), and 8 represented non-humans (Martian like characters that do not have arms or legs, have three or more eyes, have a

² This is inspired by Karmiloff-Smith (1979).

hollow body). Fig. 2 shows some of the 3D characters used³. 3D characters not pictures were used to ascertain that the participants were describing the characters themselves rather than the pictures which might affect their answers.



Fig. 2. Examples of the 3D characters used in the experiment.

In addition to the test items, four 3D real animals; two feminine and two masculine (a cow, a duck, a horse, and an elephant) were used as fillers.

3.3. Design

A factorial design ($2 \times 2 \times 3$); noun ending (*-a* versus no *-a*) \times agreement on determiner and adjective (masculine versus feminine) \times natural gender (male, female, or non-human) was used to get all the possible combinations that an Arabic-speaking learner/speaker might encounter in the input⁴. This resulted in the following 12 conditions;

³ The 3D characters were further evaluated by native Arabic speakers to make sure that they are classified as they were intended to be in the experiment.

⁴ This design is similar to the design of Perez-Pereira's (1991).

1. masculine agreement + -a ending + male human.
2. *masculine agreement + -a ending + female human.
3. masculine agreement + -a ending + non-human.
4. masculine agreement + non -a ending + male human.
5. *masculine agreement + non -a ending + female human.
6. masculine agreement + non -a ending + non-human.
7. *feminine agreement + -a ending + male human.
8. feminine agreement + -a ending + female human.
9. feminine agreement + -a ending + non-human.
10. *feminine agreement + non -a ending + male human.
11. feminine agreement + non -a ending + female human.
12. feminine agreement + non -a ending + non-human.

As indicated by the asterisk (*), some combinations are impossible in Arabic. Nevertheless, those combinations were included to see how participants behave with regard to such conditions.

3.4. Procedure

The experiment was carried out in a quiet room in the experimenter's house or in the participant's house whichever was more convenient for the participant. Each participant was interviewed individually by the experimenter except for two (2 - 3) children and three (4 - 5) children who were shy to be left with the experimenter alone and were accompanied by their mothers. The mothers were instructed to keep silent throughout the experiment. The answers were recorded using a Zoom recorder.

Each of the 12 conditions was tested twice in the following scenario:

The experimenter explained the task to the participants by saying "we are going to play a game in which you will have to describe some characters". Then, the experimenter presented the participant with an item and said "This is X" and then the participant was asked "who is this?" to make sure that the participant got the novel noun. And then the experimenter said "and this is a second X" holding the pair of the 3D characters. Then the experimenter repeated while holding the pair "This is X and this is a second X". Then one of the items was hidden and the participant was asked "which X did I hide?". The gender of the demonstratives and adjectives were manipulated depending on the condition being tested.

4. Results

The dependent variable was grammatical gender (masculine/feminine) attributed to each item. The grammatical gender was determined on the basis of agreement; i.e., the agreeing forms produced by the participant.

For each participant, the mean of feminine responses attributed in each condition was calculated. A mixed analysis of variance (ANOVA) was run with age (2-3, 4-5, 6-10, 11-15, and adults) as a between-subject variable and morphophonological ending (-a vs. no -a), syntactic agreement in the prompt

(masculine vs. feminine), and natural gender (male human vs. female human vs. non-human) as within-subject variables. Statistical analyses were performed by participant.

Fig. 3 summarizes the resulting pattern. A three-way significant interaction was found between word ending, natural gender and agreement $F(2, 386) = 17.46$, $p < 0.0001$. There were also two-way significant interactions between age and agreement $F(4, 193) = 3.43$, $p = 0.0100$, between age and natural gender $F(7, 337.86) = 5.72$, $p < 0.0001$, and between age and word ending $F(4, 193) = 9.05$, $p < 0.0001$.

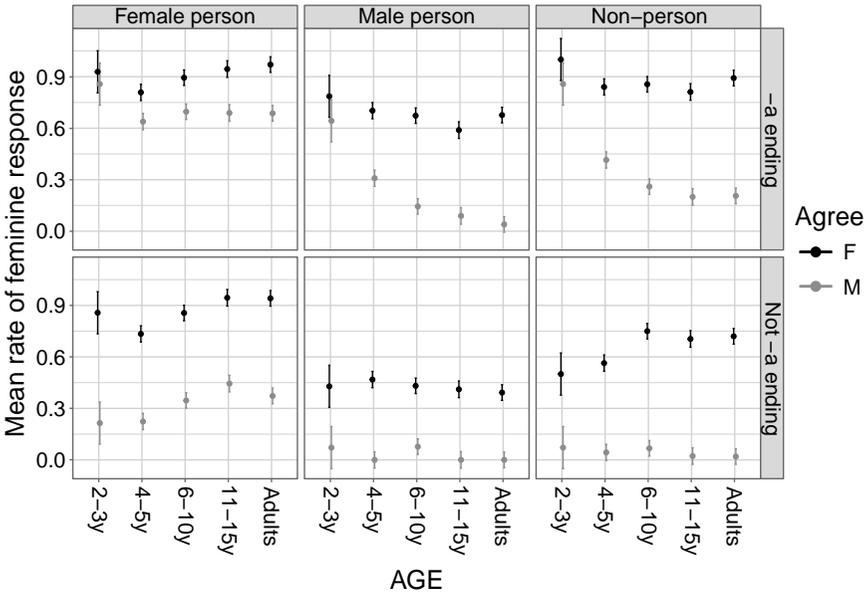


Fig. 3. Mean rate of feminine responses by age × word ending × agreement × natural gender.

When the two-way interaction between age and agreement was further investigated, a significant effect of age was found when the agreement in prompt was masculine $F(4, 197) = 3.32$, $p = 0.011$; but not when it was feminine $F(4, 197) = 0.96$, $p = 0.432$. As can be seen in Fig. 4, the rate of feminine responses attributed to the novel nouns when the agreement in prompt was feminine is nearly the same across all the age groups. On the other hand, the rate of feminine responses when the agreement in prompt was masculine decreased as participants grew older. Simple pairwise comparisons were run between the different age groups for feminine responses in the case of masculine agreement. A Bonferroni adjustment was applied. The mean of feminine responses was significantly different between the youngest age group and school-age children ($p = 0.042$),

between the youngest age group and adolescents ($p = 0.014$), and between the youngest age group and adults ($p = 0.006$).

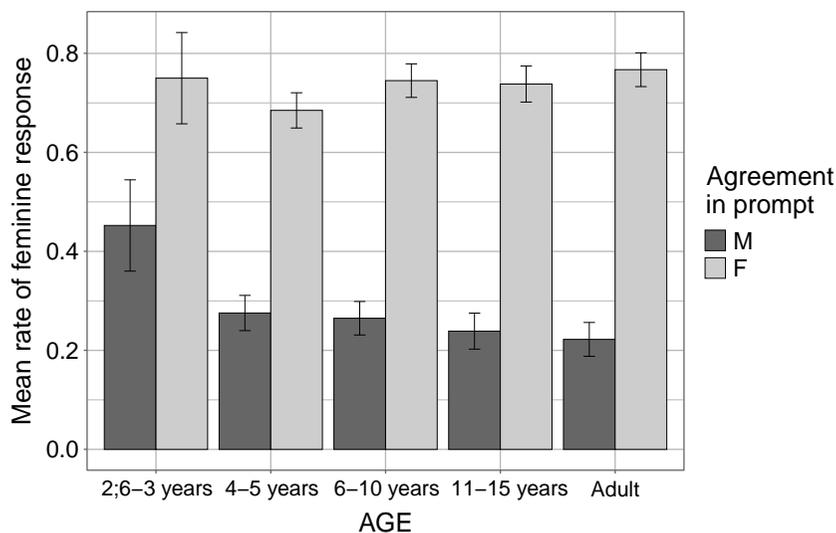


Fig. 4. Mean rate of feminine responses by age and syntactic agreement in prompt. Error bars represent standard errors of the mean (SEM).

Considering the age and noun ending two-way interaction, an effect of age was found when the nouns ended in *-a*, $F(4, 197) = 3.59$, $p = 0.007$. No effect of age was found when the novel nouns did not end in *-a*, $F(4, 197) = 1.80$, $p = 0.130$. Fig. 5. shows that the highest rate of feminine responses attributed to *-a*-ending nouns was by the youngest age group. The association between *-a* and feminine gender decreased gradually as participants grew older. Pairwise comparisons between the age groups revealed significant differences between the youngest age group and pre-schoolers ($p = 0.034$) between the youngest age group and school-age children ($p = 0.010$), between the youngest age group and adolescents ($p = 0.002$), and between the youngest age group and adults ($p = 0.008$). On the other hand, the rate of feminine responses attributed to novel nouns when they did not end *-a* was very similar among all the age groups (Fig. 5). Further post hoc tests were run to investigate the effect of ending within each age group. One-way within subject ANOVA revealed that the rate of feminine responses attributed when the nouns ended in *-a* was significantly different from the rate of feminine responses attributed when the nouns did not end in *-a* in all the age groups; $p = 0.002$ in the youngest age group and $p < 0.0001$ in all the other age groups.

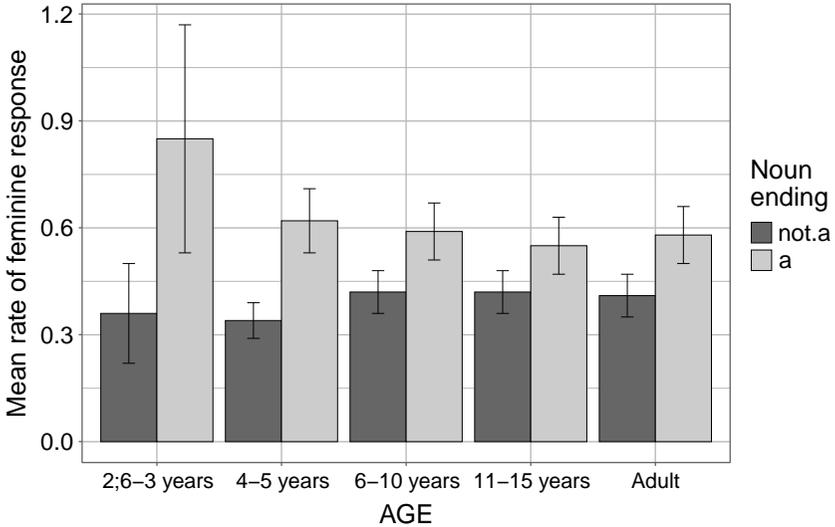


Fig. 5. Mean rate of feminine responses by age and noun ending. Error bars represent standard errors of the mean (SEM).

Moving to the two-way interaction between age and natural gender, one-way between subjects ANOVA showed a significant main effect of age $F(4,197) = 3.89$, $p = 0.004$ in the case of feminine responses attributed to female persons. Pairwise comparisons revealed significant differences in the rate of feminine responses attributed to female persons between pre-schoolers and adolescents ($p = 0.004$) and between pre-schoolers and adults ($p = 0.009$). As illustrated in Fig. 6, the rate of feminine/masculine responses attributed to novel nouns in the case of male persons is also different between the different age groups which shows an effect of age also in this case $F(4,197) = 2.98$, $p = 0.020$. However, pairwise comparisons between the age groups in the case of male persons revealed no significant differences between the different age groups. No effect of age was found when the referent of novel nouns was non-human.

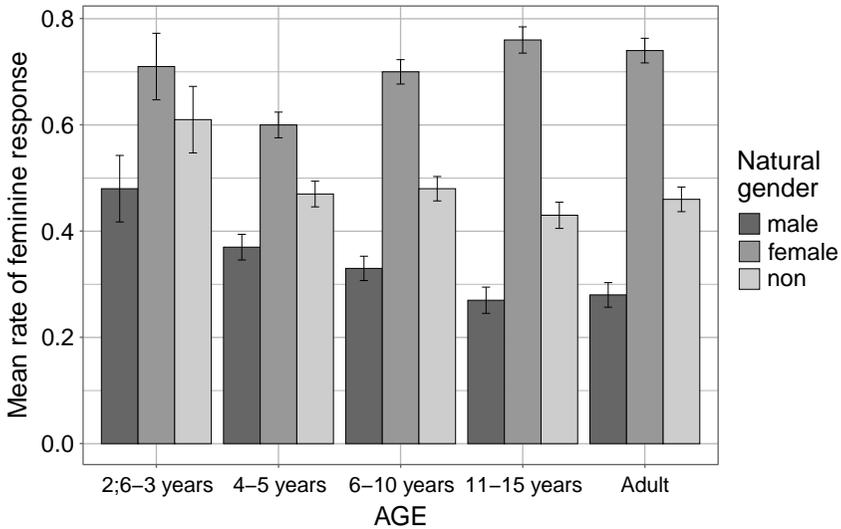


Fig. 6. Mean rate of feminine responses by age and natural gender. Error bars represent standard errors of the mean (SEM).

Furthermore, the effect size of the different cues in each age group was calculated using partial eta-squared test (η_p^2). The results are given in Table 2⁵. Partial eta-squared, which is recommended for mixed designs (Richardson, 2011), was chosen because I am interested in finding out the amount of variation in the dependent variable accounted for by each type of information, morphophonological vs. syntactic vs. semantic in each age group when non-error sources of variation being partialled out. The results of the η_p^2 that was run for the youngest age group shows that morphophonological information accounts for the majority of the variation in the responses of this age group (45%). Considering the pre-schoolers group, morphophonological information accounts for 13%, syntactic information accounts for 26%, and natural gender information accounts for only 7% of the variations in the responses in this age group ($\sum \eta_p^2 = .46$). For the school children, adolescents, and adults, syntactic agreement as well as natural gender information account for great proportions of the variations in the responses while morphophonological information accounts for only a small proportion of the variations in the responses of these age groups.

⁵ Eta squared (η^2) is also reported for the sake of comparison as a recommended practice in scientific research (Cohen, 1973; Levine & Hullett, 2002).

Table 2. The effect size of each type of information in each age group (η_p^2 and η^2)

Age group	Type of information						
	Morpho-phonological Ending		Syntactic Agreement		Natural gender		$\sum \eta_p^2$ computed %
	η_p^2	η^2	η_p^2	η^2	η_p^2	η^2	
2-3	0.45	0.34	0.23	0.13	0.11	0.05	79%
4-5	0.13	0.09	0.26	0.21	0.07	0.05	46%
6-10	0.07	0.04	0.37	0.30	0.19	0.12	63%
11-15	0.05	0.02	0.41	0.31	0.32	0.20	78%
Adults	0.08	0.04	0.47	0.35	0.30	0.18	85%

5. Discussion

This study tried to find out how the different sorts of information/cues interact with each other and how they are weighed by L1 learners/speakers over the course of development, beginning from the two-word-utterance stage to adulthood.

The results suggest that L1 learners/speakers were weighting the cues in the following scales.

- 2-to-3-year-olds:
morphophonological >> syntactic >> semantic.
- 4-to-5-year-olds:
{Syntactic agreement, Morphophonological ending} >> Natural gender
- Three older groups:
{Syntactic agreement, natural gender} >> morphophonological ending.

The effect size of each type of information in the different age groups (Table 2) show how the gender system develops gradually until it reaches its end status. Syntactic agreement becomes the defining property at a very early age (around 4-5 years). Perez-Pereira (1991) and Karmiloff-Smith (1979) also found that Spanish and French children gave more importance to syntactic agreement as they grew older though at an older age than found here. Though previous studies showed that morphophonological cues were predominating over semantic cues up to age twelve, this data from Arabic shows that the effect of the semantic cues in the school age children (6-10 years) is bigger, albeit not as big as in the two older groups, than the effect of morphophonological cues. It takes up to adolescence for the semantic cues to reach its end status.

Young language learners seem to search for overt and consistent cues (Finley & Wiemers, 2015) to help them in attributing gender to new nouns. The uniformity of *-a* makes it an appropriate candidate as a cue to the feminine gender class membership. Contrary to this, the diversity of the phonological endings in the masculine nouns does not seem to constitute an appropriate cue for masculine

gender. In Arabic, nouns either end in *-a* or not; there is no particular morphophonological ending with which masculine gender tends to correlate. Thus, the issue that Arabic learners seem to encounter is that feminine gender is characterised by a positive-correlation with noun ending; i.e. the presence of *-a*. In contrast, masculine gender is characterized by a negative-correlation with noun ending; i.e., the lack of a gender marker. If Arabic is compared to Spanish for example, we find that in Spanish, a fair proportion of the masculine nouns end in *-o* compared to a fair proportion of the feminine nouns that end in *-a*. Both genders positively correlate with noun endings. A similar and more transparent situation is found in Italian where the majority of the feminine nouns end in *-a* while the majority of the masculine nouns end in *-o*. The situation in Arabic is not as balanced as the situation in Spanish or Italian, with one gender having an overt (positive) correlation with noun ending and the other having a lack of noun ending cue or negative correlation between gender and noun ending. As a result, when the nouns ended in *-a*, young children attributed feminine gender out of proportion. Yet, when *-a* was not there, young participants started to consult other types of cues such as syntactic agreement and natural gender.

The lack of the predictive ending *-a* could in itself be a cue, just as its presence. Yet, these two types of cues do not seem to be given similar weight by the learners. In Arabic, there is a group of nouns that have *-a*/no *-a* pairs, such as the nouns in (1). Arabic learners could learn through these nouns that the lack of *-a* is a cue to masculine gender in the same way that *-a* is a cue to feminine gender. Nonetheless, the pattern observed in this study does not support that. Two possible explanations can be offered here. First, there could be a preference among the learners for the cues to be overtly coded. For that reason *-a* is treated as a cue but the lack of it is not treated as a cue in itself. Frigo and McDonald (1998) found that in order for the gender-like subclass learning to take place, the cues need to be noticeable. Second, the grammatical distinction that the *-a*/ no *-a* pairs express correlates with the semantic distinction (i.e., male vs female) which is itself not a salient cue for the young learners.

Similarly, the results demonstrated an asymmetry in the way the syntactic agreement was treated. Though feminine agreement was strongly associated with feminine gender with no differences between all the age groups, the association between masculine agreement and masculine gender followed a developmental trajectory. The association between masculine agreement and masculine gender seemed to gain more strength as participants grew older. This again may well be due to the imbalance situation in Arabic. To explain, feminine agreement is overtly coded in Arabic whereas masculine agreement is a lack of overt agreement. For example, if the nouns in (1a and 1b) were to be described by adjectives as in (2a and 2b⁶), it is always the case that feminine gender is overtly-coded by the suffixation of *-a* compared to the masculine gender which is zero-coded.

⁶ The same applies for the nouns in 1c and 1d but they are not included here because of the space limitations.

- (2) a. *ṭabiib muḥliṣ / ṭabiib-a muḥliṣ-a*
 doctor dedicated / doctor-fem dedicate-fem
 ‘A dedicated doctor.’
- b. *ṭaalib muḡtahid / ṭaalib-a muḡtahid-a*
 student hard-working / student-fem hard-working-fem
 ‘A hard-working student.’

The overt-coding of feminine gender in Arabic is not special for human referring nouns. It is also manifested in the homogeneity of the morphophonological ending attested in more than 99% of the non-human feminine nouns in Arabic. Though the case of non-human referring nouns is different from human-referring nouns in that feminine non-humans are not derived from their masculine counterparts by the affixation of *-a* in the vast majority of the nouns. Such morphophonological homogeneity among the two subclasses seems to enhance the strength of *-a* as a cue to feminine gender for Arabic learners/speakers. By and large, the morphophonological ending *-a* and the feminine syntactically agreeing determiner seem to have more strength and validity (MacWhinney et al., 1984) as cues to feminine gender compared to the lack of *-a* ending and the zero-coded masculine agreement as cues to masculine gender.

6. Conclusion

This data provides experimental evidence from a Semitic language, Arabic, which adds to the growing body of literature in gender acquisition and gender assignment. It demonstrates how L1 learners/speakers from 2 years to adulthood weight the available cues to assign gender to newly encountered nouns. Though syntactic agreement gains its role as the defining cue of the grammatical gender of the noun at a very early age (around 4-5 years), the competition between noun-internal gender-correlating information (morphophonological and semantic) develops gradually until it reaches its end status in adolescence. Overall, this investigation of Arabic gender demonstrates that, despite early bias for morphophonological cues, sensitivity to semantic and syntactic cues exists as early as 2 to 3 years. The development of grammatical gender from that stage therefore involves adjustments in cue weighting rather than discovery of the cues.

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