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Acquiring Noun Plurals in Palestinian Arabic: Morphology, Familiarity, and Pattern Frequency

Elinor Saiegh-Haddad

Bar Ilan University

Areen Hadieh

Tel Aviv University

Dorit Ravid

Tel Aviv University

The study examined the acquisition of two morphological procedures of noun pluralization in Palestinian Arabic: *Sound Feminine Plural* (SFP) and *Broken Plural* (BP). We tested if noun pluralization was affected by (1) the type of morphological procedure, (2) the degree of familiarity with the singular noun stem, and (3) the frequency of plural patterns. Thirty-six native Arabic-speaking children in three age groups were tested on three experimental tasks: a repetition task, a structured production task, and a seminatural production task. In line with earlier research, the results showed that SFP pluralization was acquired earlier and had a shorter developmental trajectory than BP plurals. Also, the errors of children showed that SFP was a dominant default procedure. However, despite its early consolidation, SFP formation was affected by familiarity with the singular noun stem. BP nouns also appeared rather early in the production of children and were affected by both familiarity with the noun stem and frequency of the plural pattern. Yet, they took longer to acquire and did not reach comparable levels to SFP in the age groups tested. The implications of the results for models of language acquisition and the acquisition of Arabic morphology are discussed.

Keywords acquisition; Arabic; broken plural; morphology; nouns; single-route model; acquisition of inflection

Correspondence concerning this article should be addressed to Elinor Saiegh-Haddad, English Department, Linguistics Division, Bar-Ilan University, Ramat-Gan, Ramt Gan 52900, Israel. Internet: saieghe@mail.biu.ac.il

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Introduction

Acquiring the inflectional system of one's first language is a fundamental task that is taken up rather early on by toddlers. The early onset of the inflectional system appears to be rooted in its distributional characteristics, including high token frequency and general and obligatory applicability (Bybee, 1995). From a semantic point of view, the inflectional system also manifests a high degree of transparency, regularity, and predictability (Ravid & Schiff, 2009). Such aspects of inflection render it structurally highly salient and accessible for young children and, in turn, facilitate the initial mapping of function, or meaning, onto inflectional units. Nonetheless, inflectional categories vary from each other in degree of *structural* transparency, with some revealing a complex and opaque relationship with their phonological representation leading, hence, to reduced levels of consistency, regularity, and predictability. Such morpho-phonological complexity constitutes a serious challenge to the successful launching of this central function of human language (Laaha, Ravid, Korecky-Kröll, Laaha, & Dressler, 2006; Ravid & Schiff, 2012).

Plural formation is a primary inflectional process and the most basic morphological marker on nouns. It also plays a central role in the morphology of noun phrases and functions as a trigger of grammatical agreement. So, if nouns carry any morphological marking in a given language, plurals are signaled on nouns as the heads of noun phrases. Also, if a language has a single category of morphological marking on the noun, this would be grammatical number. The singular marking is often zero, with duals having a much smaller distribution in the world's languages. This renders plural the central number marking in the world's languages. Although the plural system is typically a rather complex structure (Corbett, 2000) and is dependent on semantic features as well (Zapf & Smith, 2008, 2009), its centrality in morphosyntactic development contributes to its early emergence in child language and makes it one of the earliest categories surfacing in child language development (Berman, 1981; Stephany & Voeikova, 2009). In the wake of this, the course of plural acquisition has been the topic of many studies and of a great deal of controversy too (Clahsen, 1999; Marcus, Brinkmann, Clahsen, Wiese, & Pinker, 1995).

The present study examined the acquisition of two morphological procedures of noun pluralization in Palestinian Arabic, *Sound Feminine Plural* (SFP) and *Broken Plural* (BP), via experimental data elicited from 36 Palestinian-Arabic-vernacular native speaking children sampled across three age groups between 3;0 and 8;0. We had two goals: First, we wanted to gain a fuller developmental picture of how noun plurals are learned in Arabic beyond the early stages. Second, we were interested in using the critical case offered by sound

versus broken formation in the Arabic plural system as a testing ground that might allow us to shed light on current competing models for the acquisition of regular and irregular inflection, by ascertaining whether noun pluralization was affected by the type of morphological procedure (i.e., sound vs. broken plural), the degree of familiarity with specific singular noun stems, and the overall frequency of plural patterns.

Dual- and Single-Route Explanations for the Acquisition of Inflection

Research on the representation and acquisition of plural formation has been dominated by two conflicting theories: The dual-route model and the single-route model. Both models appear to provide a viable explanation for the U-shaped phenomenon depicting the acquisition of plural, as well as other inflectional systems. The *dual-route model* assumes the existence of two distinct processing systems (Clahsen, 1999; Sahin, Pinker, & Halgren, 2006)—one processing regular and another processing irregular morphology. At the onset of acquisition, a rote-learning mechanism stores both regular and irregular forms so that the child appears to be using them appropriately. This mechanism is later augmented by a rule-based mechanism that applies to all members of the appropriate symbolic category (e.g., N + plural marker, V + past tense marker) not yet entrenched in long-term memory, that is, without a deep memory trace—resulting in over-regularization, for instance, *mans, knowed*. Gradually, a mature morphological system develops that contains two systems: One handles regular inflection by an abstract, symbolic rule that can be extended to nonce forms, and another stores irregular forms by lexical memory whose retrieval blocks the application of the rule (Jaeger et al., 1996).

Hence, according to the dual-route model, as proposed by Pinker (1999), regular forms are computed in the grammar by combinatorial operations that assemble morphemes and simplex words into complex words and larger syntactic units (Clahsen, 1999; Sahin et al., 2006). An important feature of this view is the dissociation of singular stem (base) and affix (prefix or suffix) as distinct symbolic variables (Berent, Pinker, & Shimron, 2002; Pinker & Ullman, 2002). Further, Pinker and his associates suggest that irregular forms are handled by an associative network of subregularities that clusters together minor patterns such as *drink / drank, sing / sang* which may cause occasional mistakes such as *bring / brang* under experimental conditions, even in adults (Pinker, 1999; Pinker & Ullman, 2002; Prasada & Pinker, 1993). As Arabic plurals consist of both linear stem-suffix structures (sound plurals) as well as nonlinear

stem-changing structures (broken plurals), this model generates the prediction that only broken plurals should be affected by associative memory constraints such as frequency and familiarity.

A second account of the acquisition and processing of regular and irregular forms denies a split in processing mechanisms and proposes *single-route models* to handle both types of inflectional morphology: regular and irregular. Single-route models assume an associative memory mechanism (a connectionist model) which regards each entry as a set of features that are shared by many other entries that overlap in their representation. According to these models, learning consists of strengthening or weakening connections between pairs of units as a result of the changing nature of linguistic input and is thus strongly affected by factors like frequency, similarity, consistency, and salience (McClelland & Patterson, 2002). The network learns to compute the most probable inflected form for any input string by using learning algorithms that capture the statistical regularities between input and output strings, and learns from both external factors such as child-directed speech as well as from the "hidden units" of memory constructed between these strings. Symbolic categories arise in such a learning mechanism as emergent properties of the system, which can generalize automatically to both regular and irregular new forms. This is because the same mechanism computes predictable and exceptional forms (Daugherty & Seidenberg, 1994; Plunkett & Marchman, 1993; Rumelhart & McClelland, 1986). Under the single-route view, the learning network improves performance on plurals over many learning trials, resulting in a gradual developmental process where overgeneralization is conditioned by linguistic experience, coupled with the similarity of the exemplar being learned to others already stored, its consistency and salience, as well as its frequency. The single-route model thus generates the prediction that both Arabic sound and broken plurals should be affected by associative memory properties such as frequency and familiarity.

The two models discussed above differ in their treatment of the notions of *frequency* and *regularity*. With regard to frequency, the dual-route model stipulates that regular plural forms are not memorized or listed in the lexicon. Hence, only the frequency of singulars should matter. In contrast, single-route models regard the frequency of both singular and plural forms as critical, because both regular and irregular forms are listed in the mental lexicon.

Moreover, according to this latter view, frequency and regularity do not always coincide. In English they do, with regular patterns being more frequent than irregular patterns. Plural minor patterns and exceptions (umlaut such as *foot–feet, mouse–mice*, and *-en* plurals such as *child–children*) are infrequent in English as types, and most of them are not frequent as past tense irregular tokens

either. Unlike English, languages such as German and Arabic do not have a clearly single dominant form. The German plural system consists primarily of phonologically unrelated plural allomorphs. The literature in this domain appears to argue for the *-s* plurals as the default case (Clahsen, 1999). Yet, these are neither the first ones to emerge, nor are they the only ones to be overgeneralized (Laaha et al., 2006; Ravid et al., 2008). Arabic too is a language that does not conform to an English-like regular-frequent / irregular-infrequent plural split. In the next section we describe the Arabic plural system.

The Number System in Arabic

Perhaps one of the most distinctive linguistic features of Arabic is its diglossic nature (Haeri, 2000; Saiegh-Haddad, 2003). According to Ferguson (1959), a diglossic context is characterized by a stable coexistence of two linguistically related language varieties, a "High" variety and a "Low" variety, which are used for two sets of complementary social functions with slight and insignificant overlap in use. *Modern Standard Arabic* is a codified variety of Arabic, the modern descendant of *Classical Arabic*, and is believed to be uniform across the Arabic-speaking world (but see van Mol, 2003, for example). In contrast, spoken Arabic vernaculars, or *Spoken Arabic*, is the language used for everyday speech and it does not have a conventional written form. The origins of Arabic diglossia may be traced back to the standardization of Arabic, which began in the 8th and 9th centuries A.D. and has produced a set of norms that the early grammarians called *fusha*. Over the course of many years, the continued use of this favored set of written linguistic norms has led to substantial differences between the dynamic spoken vernaculars and the fixed written language, making the two language varieties remarkably distinct and linguistically distant. This linguistic distance has been shown to affect the acquisition of basic language and literacy skills in children (Saiegh-Haddad, 2003, 2004, 2007; Saiegh-Haddad, Levin, Hende, & Ziv, 2011).

The general architecture of number marking applies rather similarly to both Standard and Spoken Arabic. Arabic has a four-way grammatical system of number: singular, dual, plural, and collective. The singular noun in Arabic is the free stem and the basic building block of the inflectional system. Inflectional bound morphemes attach to the singular stem noun and they vary according to the noun's number and gender, and in Standard Arabic, according to its case too. Because this study investigates the acquisition of plural forms in spoken Palestinian Arabic, not the dual or the collective forms, the following section offers a comprehensive account of the plural system.

Plural Formation in Arabic: Sound and Broken Plurals

Plural nouns in Arabic refer to more than two of a countable entity. Plural formation in both Standard Arabic and the spoken Palestinian vernacular investigated in this study follows two morphological procedures. The first involves linear suffixation and the second involves the nonlinear superimposition of templatic consonant-vowel patterns onto triradical roots. According to Holes (2004), the primary factor determining whether a given noun forms its plural by suffixation or by templatic superimposition is the morphological structure of its singular form coupled with its meaning. Linear or so-called *sound plural* formation involves the attachment of a suffix to a nominal stem—in Palestinian Arabic the plural suffix is either the masculine plural suffix *-i:n* (*masculine sound plural* [MSP]) or the feminine plural suffix *-a:t* (*feminine sound plural* [FSP]) (Versteegh, 1997). This procedure has been termed "regular." Yet, in Arabic, it is not the most frequent procedure, nor are the two gender-related suffixes equally productive. The masculine plural suffix is restricted to a closed class set of passive and active participial nouns (e.g., *muwazziʕ* 'distributor' → *muwazziʕ i:n/u:n*), nouns of profession/occupation (e.g., *dahhan* 'painter'→ *dahhani:n/u:n*), and *–iyy*-suffixed relational adjectives (e.g., *qudsiyy* 'from El-Quds-Jerusalem' → *qudsiyyi:n/u:n*). In addition, some so-called primitive nouns (i.e., nouns that are not verbal derivatives) such as proper nouns also take the MSP. The feminine plural suffix is vastly more productive than the masculine plural suffix and it applies to a wider range of nouns. It affects the same categories taking the MSP, like participial forms, nouns of profession/occupation, and *– iyya* relational nouns, mainly, when they refer to rational females (e.g., *ka:teba* 'Fm writer' → *ka:teba:t; muʕ allima* 'Fm teacher → *muʕ allima:t*). Yet, it also affects several other types of nouns including grammatically feminine nouns (i.e., marked by a feminine suffix such as *mɑktaba* 'library' → *mɑkaba:t*) as well as grammatically masculine nouns (e.g., *ħamma:m* 'bathroom' → *ħamma:ma:t*) and borrowings (e.g., *balo:n 'balloon'* → *balona:t*) (Holes, 2004).

The second pluralizing procedure is the more common Semitic procedure of nonlinear, simultaneous root-and-pattern affixation, that is, interdigitating consonant-vowel patterns on the root radicals of the singular noun. This procedure is referred to as *Broken Plural* (BP) and it involves changing the form of the singular noun through various morpho-phonological processes, such as long vowel insertion, consonant gemination, and the affixation of consonants besides those of the root (Holes, 2004), for example, *kalb 'dog'*→ *kila:b*. Broken plurals are formally represented as patterns (vocalic tiers) interdigitated by root consonants, indicated by C's. For example, the plural form of *jamal*

'camel'→ *jima:l* uses the plural pattern CvCv:C. Wright (1896–98) lists 29 broken plural patterns as in common use in Classical Arabic, "most of which are still in use, but perhaps only about half of which are commonly encountered in MSA" (Holes, 2004, p. 168). These patterns are phonetically altered in very general and predictable ways in spoken Arabic (Levin, 1994). For instance, the Standard plural pattern CvCv:C surfaces as CCv:C in spoken Arabic. Hence, *jima:l* 'camels' becomes *jma:l* and *buyu:t* 'houses' becomes *byu:t*.

The basic plural system described above for Modern Standard Arabic applies also, *mutatis mutandis*, in the spoken Arabic vernaculars. The main formal difference is that, with the general loss of the case system, the *-u:n* /*-i:n* distinction in the masculine sound plural has been lost in Spoken Arabic. In turn, a generalization of the oblique case form *-i:n* for all masculines and *-a:t* for all feminine sound plurals is now found everywhere (Holes, 2004, p. 170).

The plural system of Arabic outlined above has led to the belief that Arabic is an archetype of a minority-default inflectional system. That is, a system in which a regular linear affixational process applies to fewer forms in the language than the irregular stem modifying process (McCarthy & Prince, 1990). Contrary to this stance, however, Idrissi (1997) argues for largely systematic and predictable stem alterations in broken plural formation indicating, hence, regularity in this inflectional procedure as well. In the same way, Boudelaa and Gaskell (2002) show, on the basis of distributional evidence, that whereas both sound and broken plurals are qualitatively productive in Arabic, broken plural is quantitatively the more productive process and it involves more nominal forms. This latter view on the plural system of Arabic has significant implications for acquisition. In the next section we review recent research on the native acquisition of the plural inflectional system of Arabic.

Acquiring the Plural Inflectional System in Arabic

Although there have been a few studies of diverse aspects of children's acquisition of contemporary Arabic (Abu-Haidar, 1979; Al-Akeel, 1998; Badry, 1983, 2005; Henkin, 1998; Ibrahim & Eviatar, 2009; Levin, Saiegh-Haddad, Hende, & Ziv, 2008; Omar, 1973; Saiegh-Haddad, 2003, 2004, 2005, 2007; Saiegh-Haddad, et al., 2011), including morphology (Boudelaa & Marslen-Wilson, 2005) little has been published on the native acquisition of Arabic plural forms.

Ravid and Farah (1999) tested sound and broken plurals in 48 native speaking children of Palestinian Arabic 2–5 years of age. Children were asked to provide the plural form of 42 noun stimuli in three categories: sound masculine plural, sound feminine plural, and broken plurals following seven plural

patterns. The findings revealed that the unmarked form of pluralization was the sound feminine plural suffixed by *-a:t*. This category was acquired early on and reached a plateau by age 3. Further, it was the most preferred plural formation option in erroneous responses. The masculine sound plural suffixed by *-i:n* was found to be the least preferred option of pluralization in both correct and erroneous responses. The so-called irregular broken plural category was found to be in the middle, between the other two sound plural extremes, with a learning curve similar to that of the sound masculine but with increasing presence in the erroneous responses of the oldest age groups.

Ravid and Farah (2009) report a case study of a Palestinian Arabic speaking child's learning of plural formation during 1 year (1;8–2;8). The results indicated that two major plural categories were active in the child's early lexicon: the broken plural category, which occurred most frequently in his productive speech, and the sound feminine category, which lagged somewhat behind but made up in being the target of most erroneous forms. All other number forms—sound masculine, duals, and collectives—were found to constitute between 4% and 22% of all the plural forms generated, and they were always correct. This led to the conclusion that most of the active learning underway at this specific developmental stage occurred in the sound feminine and the broken plural categories.

Ravid and Hayek (2003) focused on the acquisition of three number categories: sound feminine plural, dual, and collective nouns in the elicited picture-naming speech of 58 native speakers of Palestinian Arabic ages 3;6–4;6, 5;0–6;0, 6;0–7;0, and 7;0–8;0. Analysis of the correct responses showed a clear developmental pattern in the acquisition of sound feminine plural nouns, as well as in the dual nouns, and no increase beyond the initial 50% level of collective production. Broken plurals, which did not constitute a target category in this study, appeared nonetheless in the productions of children from the relatively older age groups as alternative forms to the ones elicited in the study, replacing collectives and sound feminine plurals (e.g., *mwa:z* 'bananas' for collective *mo:z* or sound feminine plural *moza:t*). The occurrence of non-solicited broken plural forms constitutes indirect evidence for the importance of this morphological category in preschool and early grades in school.

Against the background presented in the previous sections, the current study aimed to examine the development of the two major plural categories of Arabic—SFP and BP in children ages 3–8, so as to gain a fuller developmental picture of how noun plurals are learned in Arabic beyond the earlier stages. Moreover, we took into account both frequency and familiarity with nouns and morphological patterns as possible factors interacting with morphological

procedure in acquisition. The study was conducted in a Palestinian Arabic vernacular spoken in the north of Israel.

Method

Participants

The sample of the study consisted of 36 children from an Arabic-speaking city in the north of Israel, in three age groups: 3;0–4;0 (mean age 3.66; $N = 12$), 5;0–6;0 (mean age 5.37; $N = 12$), and 7;0–8;0 (mean age 7.16; $N = 12$). All children were monolingual native speakers of Palestinian Arabic from a middle-to-high socioeconomic background, with no hearing, language, or developmental problems.

Materials

In order to glean insight into the acquisition of plural formation in Arabic, the study employed three tasks that varied in the degree of spontaneity and meta-linguistic awareness. The first was a repetition task (with 24 items), which required participants to repeat the plural noun presented by the experimenter. This task aimed to examine children's knowledge of plural forms based on the idea that children can only repeat structures they have acquired, and that linguistic repetition indicates working memory capacity and simultaneous syntactic processing capacity (Stokes, Wong, Fletcher, & Leonard, 2006). This task was administered first so that young children with little experience with structured elicitations may be introduced to the domain of plural formation. The task did not require a high degree of metalinguistic manipulation. Neither did it require novel linguistic production.

The second task was a structured production task modeled after the classical Wug test (Berko, 1958). This task (with 24 items) required participants to provide the plural form of a target singular noun presented by the experimenter. This production task aimed to examine children's ability to inflect a singular noun under structured experimental context-free conditions and hence required a higher degree of meta-linguistic awareness.

The third task was a seminatural production task (with 24 items) that employed a less rigid experimental design—a play context (Lotto game). This game required one child to instruct another child to complete a colored board with picture cards depicting plural objects. The playful naming task provided an authentic context for the spontaneous production of noun plurals, with children not being aware of the fact that they are being tested, and with no explicit focus on plural formation. At the same time, this seminatural task provided a

structured, convergent, and reliable method of assessing the *instructing* child's knowledge of noun plurals.

Each of the three tasks delineated above comprised a total of 24 items that were evenly distributed between two morphological structures: sound feminine plural ($n = 12$) and broken plural ($n = 12$). Items within each morphological structure were further classified into high familiarity and low familiarity based on the singular noun stem, 6 items each within each morphological structure cell: SFP and BP. Because all sound feminine plurals involve the attachment of the *–a:t* suffix, this category constitutes a single entity. In contrast, we tested several broken plural patterns. Hence, items within the broken plural morphological category were further classified as high-frequency broken plural pattern or low-frequency plural pattern, 3 items within each cell of familiarity and frequency levels. The Appendix offers sample items classified by morphological structure (SFP vs. BP), familiarity of singular noun (high vs. low), and frequency of plural pattern (high vs. low).

Procedure

The study tested children's plural formation as a function of plural morphological structure, familiarity with the singular noun stem, and frequency of the broken plural pattern. Hence, this investigation warranted a classification of items in terms of familiarity and frequency.

The degree of familiarity with the singular noun stem was determined based on the subjective judgement of kindergarten teachers. A list of 200 singular nouns was compiled that was derived from children's books and from interviews with preschool teachers. This list was distributed to 20 preschool teachers who were asked to rate the nouns on a 5-point scale in terms on their estimated degree of familiarity on the part of children. These ratings were then used to classify the nouns as either high familiarity, if more than 15 of the 20 judges agreed they had at least a familiarity level of 80%, or low familiarity, if at least 15 out of the 20 judges agreed they had a familiarity level lower than 60%. Familiarity with the singular noun stem was then used to classify the derived plural forms as low or high in familiarity. Given the fact that we tested several broken plural patterns, it was necessary to take the frequency of these different plural patterns into account. Moreover, the view that broken plurals might not be stored as full forms but rather as roots and plural templates (Boudelaa & Marslen-Wilson, 2001) warrants this manipulation.

The frequency of the broken plural pattern was determined based on earlier research with native Arabic-speaking children (Boudelaa & Gaskel, 2002; Ravid & Farah, 1999, 2009). On the basis of this research, the following

high-frequency plural patterns were targeted: *CCa:C* (e.g., *kla:b* 'dogs'), *CCu:C* (e.g., *rfu:f* 'shelves'), and CaCa:CeC (e.g., *maɣa:sel* 'sinks'). The following low-frequency broken plural patterns were targeted: CaCaCi:C (e.g., *fanaǯ:n* 'mugs'), CaCaCCi:C (e.g., *banat̲li:n* 'trousers'), and CuCCa:C (e.g., *ʔum̲sa:n* 'shirts').

The repetition task required participants to repeat the plural noun presented by the experimenter (the second author, a qualified speech-language pathologist and a native speaker of the same dialect of Palestinian Arabic spoken by the participants) in both the oral and the visual modes simultaneously. For example, the experimenter showed a picture to the child and said: "Here I have three ducks." Then she repeated the plural noun "ducks" and asked the child to repeat it after her.

The structured production task required participants to provide the plural form of a target singular noun presented by the experimenter in both the oral and the visual modes simultaneously. The singular noun was presented within a fixed sentence, and with the support of a picture, and participants were asked to complete the fixed sentence frame using the plural form. For example, the experimenter showed a picture of a door and said: "Here there is one door" and then with a rising intonation eliciting a response said: "And here there are three?" Then the participant was asked to complete the interrupted sentence by providing the target plural form.

The seminatural production task required one child to instruct another child to complete a colored board with picture cards that depicted plural objects. This playful Lotto game used two sets of boards, each with 8 differently colored squares (red, blue, pink, green, brown, yellow, grey, white), and a set of 24 picture cards. Each card was a depiction of multiple objects (e.g., 3 buses). The tested child received 3 boards. On each colored square on the board there was a picture of multiple objects (e.g., three buses on a red square). The participating second child (who was not tested) received one board with colored but empty squares, and a pile of picture cards. A screen was placed between the two children so as to prevent nonverbal cues such as pointing. Then the experimenter said to the tested child: "Your colleague has got an empty board with different colors. His task is to fill out this board with different objects—please tell him on which color to put the objects. For example, tell him to put the cars on the yellow square, or put the doors on the white square. Now it's your turn."

The repetition task was administered first followed by the structured production and then the seminatural production task. This order of task administration was meant to help children proceed gradually from more structured into more

Table 1 Mean percent correct responses by morphological structure and task

	Sound Feminine Plurals			Broken Plurals		
Age Group	Repetition	Structured Production	Seminatural Production	Repetition	Structured Production	Seminatural Production
3–4	95.83	79.86	63.19	95.83	16.67	26.38
	(12.05)	(26.46)	(13.51)	(7.53)	(17.41)	(19.08)
5–6	100	81.94	74.30	99.30	43.06	50.00
	(0)	(21.27)	(21.45)	(2.40)	(25.08)	(17.40)
7–8	99.31	91.66	87.50	100	74.31	70.83
	(2.40)	(12.31)	(13.53)	(0)	(17.21)	(13.53)

Note. Sample size for each age group was $N = 12$. Standard deviations are given in parentheses.

spontaneous and naturalistic elicitation procedures. Children's responses were scored on a binary basis as either correct (receiving one score) or incorrect (receiving a zero score). No partial scores were assigned. Raw scores were all converted into percent correct scores.

Results

We conducted both an analysis of variance (ANOVA) by subject (i.e., with subject as the random variable and item as the fixed variable) and by item (i.e., with item as the random variable and subject as the fixed variable). This was done in order to validate findings from one analysis by the findings obtained from the other. The ANOVA by subject is reported as F_1 and the analysis by item as F_2. In general, the results from both analyses were very similar. Hence, the means reported in the text refer to the analysis by subject only. It is noteworthy that an analysis by item was not possible in comparing BP nouns with high-frequency versus low-frequency plural patterns. This is because we had only three items per cell.

Main Results: Type of Plural and Task

We first present our results by the two main factors of *morphological structure* (i.e., sound feminine plural versus broken plural) and *task* (i.e., repetition, structured production, and seminatural production). Table 1 presents means and standard deviations of children's correct responses in the three age groups.

A three-way ANOVA with repeated measures on morphological structure (2: SFP, BP) and task (3: repetition, structured production, seminatural production), with age as a between-subject factor, was used to analyze children's

performance. An effect of age emerged, $F_1(2,33) = 19.77, p < .001, \eta_p^2 = .55$; $F_2(2,132) = 142.49, p < .001, \eta_p^2 = .68$, with an incremental developmental progression in children's performance. A post hoc Bonferroni analysis showed that all three age groups differed significantly from each other. Morphological structure was also significant, $F_1(1,33) = 90.76, p < .001, \eta_p^2 = .73$; $F_2(1,66) = 41.16, p < .001, \eta_p^2 = .42$, with SFP yielding higher scores ($M = 85.96\%$) than BP ($M = 64.04\%$). Task yielded a third significant main effect, $F_1(2,66) = 156.68, p < .001, \eta_p^2 = .83$; $F_2(2,66) = 55.63, p < .001, \eta_p^2 = .63$, with repetition yielding the highest scores ($M = 98.38\%$), significantly different from the two other tasks, which did not differ from each other (structured production, $M = 64.58\%$; seminatural production, $M = 62.04\%$). All two-way interactions were significant: Age by morphological structure, $F_1(2,33) = 7.8$, $p < .003$, $\eta_p^2 = .32$; $F_2(2,132) = 28.37$, $p < .001$, $\eta_p^2 = .30$; age by task, $F_1(4,66) = 10.26$, $p < .001$, $\eta_p^2 = .38$; $F_2(4,132) = 26.24$, $p < .001$, $\eta_p^2 = .44$; and morphological structure by task, $F_1(2,66) = 54.03$, $p < .001$, $\eta_p^2 = .62$; $F_2(2,66) = 12.90$, $p < .001$, $\eta_p^2 = .28$. In addition, the three-way interaction of age by morphological structure by task was found to be significant, $F_1(4,66) = 5.7, p < .002, \eta_p^2 = .26$; $F_2(4,132) = 8.78, p < .002, \eta_p^2 = .21$. This interaction is presented in Figure S1 of Appendix S1 in the Supporting Information online.

The sources of the interactions were investigated using Bonferroni analyses, and yielded the following results. In the 3-year-olds, the seminatural production of SFP nouns was higher than that of BP nouns. Repetition of SFP nouns in this group was higher than the seminatural production of SFP nouns, while repetition of BP nouns was higher than the production of BP nouns in both structured and seminatural tasks. In the 5-year-olds, however, SFP and BP repetition was higher than in both production tasks; and SFP production was higher in both structured and seminatural tasks than BP production. In the 7-year-olds, both SFP and BP repetition reached ceiling; SFP production was equally high in both tasks, while BP learning was still underway, as reflected in children's performance on the two production tasks.

Familiarity Effects on Two Productions Tasks

Recall that stimulus items were divided into two levels of familiarity based on the singular noun: high versus low familiarity. We tested the effect of familiarity as a within-subject factor on children's performance. Children's performance on the repetition task did not yield any main effect or any significant interactions. Therefore, in the following analyses we present the results from the two production tasks only.

Table 2 Mean percent correct responses by morphological structure and familiarity on structured production

Age Group	Sound Feminine Plurals		Broken Plurals	
	High Familiarity	Low Familiarity	High Familiarity	Low Familiarity
3–4	90.28	69.44	20.83	12.50
	(28.83)	(26.43)	(21.46)	(17.58)
5–6	88.88	75.00	58.33	27.77
	(19.24)	(26.11)	(30.56)	(21.71)
7–8	95.83	87.50	84.72	63.88
	(7.53)	(20.25)	(19.40)	(23.39)

Note. Sample size for each age group was $N = 12$. Standard deviations are given in parentheses.

Table 2 presents means and standard deviations of children's correct responses in the three age groups as a function of morphological structure (SFP vs. BP) and familiarity (high vs. low) on the structured production task.

A three-way ANOVA with repeated measures on morphological structure (2: SFP, BP) and familiarity (2: high, low), with age as a between-subject factor, was used to analyze children's performance on the structured production task. The results showed a significant main effect of age, $F_1(2,33) = 13.96, p < .001$, $\eta_p^2 = .46$; $F_2(2,40) = 165.15, p < .001, \eta_p^2 = .89$, with an incremental developmental progression in children's performance, yet the difference between the two youngest groups did not reach significance. Morphological structure was also significant, $F_1(1,33) = 89.06, p < .001, \eta_p^2 = .73$; $F_2(1,20) = 65.47$, $p < .001, \eta_p^2 = .77$, with SFP nouns yielding higher scores ($M = 84.49\%$) than BP nouns ($M = 44.67\%$). Familiarity yielded a third significant main effect, $F_1(1,33) = 51.66, p < .001, \eta_p^2 = .61$; $F_2(1,20) = 11.73, p < .001$, $\eta_p^2 = .37$, with high-familiarity items yielding higher production scores ($M = 73.15\%$) than low-familiarity items ($M = 56.01\%$). The two-way interaction of age by morphological structure was significant, $F_1(2,33) = 9.85, p < .001$, $\eta_p^2 = .37$; $F_2(2,40) = 65.88, p < .001, \eta_p^2 = .77$. However, the interaction of age by familiarity was not significant. The most important finding is the significant three-way interaction of age by morphological structure by familiarity, $F_1(2,33) = 4.76, p < .02, \eta_p^2 = .22$; $F_2(2,40) = 16.12, p < .02, \eta_p^2 = .45$. This interaction is depicted in Figure S2 of Appendix S1 in the Supporting Information online.

Table 3 Mean percent correct responses by morphological structure and familiarity on seminatural production

Age Group	Sound Feminine Plurals		Broken Plurals	
	High Familiarity	Low Familiarity	High Familiarity	Low Familiarity
3–4	69.44	56.94	41.67	11.11
	(22.28)	(19.41)	(28.87)	(12.97)
5–6	73.61	75.00	69.44	30.56
	(19.41)	(26.11)	(22.29)	(19.89)
7–8	87.50	87.50	95.83	45.83
	(20.26)	(20.25)	(7.54)	(22.61)

Note. Sample size for each age group was $N = 12$. Standard deviations are given in parentheses.

Bonferroni analyses yielded the following sources of the interaction. In 3-year-olds, SFP nouns scored significantly higher than BP nouns, which scored very low. Moreover, familiar SFP nouns scored higher than nonfamiliar ones, while familiarity did not play a role in the case of BP nouns. In 5-year-olds, SFP nouns still scored significantly higher than BP nouns. However, familiarity did not play a significant role in 5-year-olds' SFP nouns (though nonfamiliar items showed a lower score than familiar items), but it did play a role in the case of BP nouns, with familiar nouns scoring more than twice as high as nonfamiliar nouns. The same pattern was replicated in the 7-year-olds, though scores were higher across all categories.

Table 3 presents means and standard deviations of children's correct responses in the three age groups as a function of morphological structure (SFP vs. BP) and familiarity (high vs. low) on the seminatural production task.

A three-way ANOVA with repeated measures on morphological structure (2: SFP, BP) and familiarity (2: high, low), and with age as a between-subject factor, was used to analyze children's performance on the seminatural production task. An effect of age emerged, $F_1(2,33) = 20.98$, $p < .001$, $\eta_p^2 = .56$; $F_2(2,40) = 61.52$, $p < .001$, $\eta_p^2 = .76$, with an incremental gain in children's accurate performance; a post hoc Bonferroni analysis showed that all three age groups differed significantly from each other. Morphological structure was also significant, $F_1(1,33) = 54.8$, $p < .001$, $\eta_p^2 = .62$; $F_2(1,20) = 41.55$, $p < .001$, $\eta_p^2 = .68$, with SFP nouns yielding higher scores ($M = 75\%$) than BP nouns ($M = 49.07\%$). Familiarity yielded a third significant main effect, $F_1(1,33) = 64.71$, $p < .001$, $\eta_p^2 = .66$; $F_2(1,20) = 30.70$, $p < .001$, $\eta_p^2 = .61$, with

Table 4 Mean percent correct responses on BP items by familiarity and pattern frequency on structured production

	High Familiarity		Low Familiarity	
Age Group	High Pattern Frequency	Low Pattern Frequency	High Pattern Frequency	Low Pattern Frequency
3–4	22.22	19.44	19.44	5.55
	(29.59)	(22.29)	(30.97)	(12.97)
5–6	63.89	52.78	36.11	19.44
	(36.12)	(36.12)	(30.01)	(22.29)
7–8	86.11	83.33	75.00	52.78
	(17.16)	(26.59)	(28.87)	(33.21)

Note. Sample size for each age group was $N = 12$. Standard deviations are given in parentheses.

high-familiarity nouns yielding higher production scores ($M = 72.92\%$) than low-familiarity nouns ($M = 51.16\%$). In addition, the two-way interaction of morphological structure by familiarity was significant, $F_1(1,33) = 42.96$, $p < .001$, $\eta_p^2 = .57$; $F_2(1,20) = 21.50$, $p < .001$, $\eta_p^2 = .52$. This interaction is presented in Figure S3 of Appendix S1 in the Supporting Information online.

Bonferroni analyses showed that the seminatural production of SFP nouns did not differ as a function of familiarity, whereas familiar BP nouns yielded twice as high a score as nonfamiliar nouns. In addition, unfamiliar SFP nouns scored significantly higher than unfamiliar BP nouns.

Frequency Effects on Two Production Tasks

Recall that BP nouns were divided into those belonging to high- versus low-frequency plural patterns. The following analyses tested the effect of pattern frequency as a within-subject factor on accurate BP nouns performance. Children's performance on the repetition task did not yield any main effect of pattern frequency, or any significant interactions. Therefore, in the following analyses we focus on the two production tasks.

Table 4 presents means and standard deviations of children's correct responses on BP nouns in the three age groups as a function of singular-noun familiarity (high vs. low) and plural pattern frequency (high vs. low) on the structured production task.

A three-way ANOVA with repeated measures on noun familiarity (2: high, low) and pattern frequency (2: high, low), and with age as a between-subject factor, was used to analyze children's performance on the BP nouns in the

Table 5 Mean percent correct responses on BP items by familiarity and pattern frequency on seminatural production

	High Familiarity		Low Familiarity	
Age Group	High Pattern Frequency	Low Pattern Frequency	High Pattern Frequency	Low Pattern Frequency
3–4	50.00	33.33	13.88	8.33
	(36.23)	(31.78)	(17.16)	(15.07)
5–6	80.55	58.33	30.55	30.55
	(30.01)	(28.86)	(22.28)	(26.43)
7–8	100	91.66	61.11	30.55
	(0)	(15.07)	(23.92)	(36.12)

Note. Sample size for each age group was $N = 12$. Standard deviations are given in parentheses.

structured production task. An effect of age emerged, $F_1(2,33) = 24.4, p < .001$, $\eta_p{}^2 = .60$, with an incremental development in children's accurate performance, and with all three age groups differing from each other. Familiarity yielded a second significant main effect, $F_1(1,33) = 33.29$, $p < .001$, $\eta_p{}^2 = .50$, with BP nouns with a high-familiarity singular stem yielding higher plural production scores ($M = 54.63\%$) than those with a singular noun low in familiarity ($M = 34.72\%$). The two-way interaction of age by familiarity was significant, $F_1(2,33) = 3.48$, $p < .05$, $\eta_p{}^2 = .17$. Pattern frequency did not yield a main effect. However, the two-way interaction of familiarity by pattern frequency was significant, $F_1(1,33) = 12.21$, $p < .002$, $\eta_p{}^2 = .27$. This interaction is presented in Figure S4 of Appendix S1 in the Supporting Information online.

Bonferroni analyses showed that pattern frequency did not affect the production of high-familiarity nouns. However, in the case of low-familiarity nouns, high-frequency plural patterns scored significantly higher than low-frequency patterns. Moreover, high-familiarity nouns of high-frequency patterns scored higher than low-familiarity nouns with the same patterns.

Table 5 presents means and standard deviations of children's correct responses on BP nouns in the three age groups as a function of singular noun familiarity (high vs. low) and plural pattern frequency (high vs. low) on the seminatural production task.

A three-way ANOVA with repeated measures on familiarity (2: high, low) and pattern frequency (2: high, low), with age as a between-subject factor, was used to analyze children's performance on the BP nouns in the seminatural production task. An effect of age emerged, $F_1(2,33) = 20.94$, $p < .001$,

$\eta_p^2 = .56$, with an incremental developmental progression in children's performance, and with all three age groups differing from each other. Singular noun familiarity yielded a second significant main effect, $F_1(1,33) = 112.37$, $p < .001$, $\eta_p^2 = .77$, with BP nouns with a high-familiarity singular stem yielding higher plural production scores ($M = 68.98\%$) than those with a low-familiarity noun stem ($M = 29.16\%$). The two-way interaction of age by familiarity was significant, $F_1(2,33) = 3.81$, $p < .04$, $\eta_p^2 = .19$. Pattern frequency did not yield a main effect on this task either. However, as before, the two-way interaction of familiarity by pattern frequency was significant, $F_1(1,33) = 12.31$, $p < .002$, $\eta_p^2 = .27$. This interaction is presented in Figure S5 of Appendix S1 in the Supporting Information online.

Bonferroni analyses showed no effect of pattern frequency in the seminatural production of either high- or low-familiarity items. Nontheless, in both categories plural nouns with high-frequency plural patterns showed higher scores than those with low-frequency patterns—though the difference did not reach satisfactory levels of statistical significance. The interaction derives from the fact that high-familiarity nouns using high-frequency patterns scored significantly higher than low-familiarity nouns using low-frequency patterns, and also from the fact that high-familiarity nouns using low-frequency patterns scored significantly higher than low-familiarity nouns using high-frequency patterns.

Analysis of Error Patterns

Beyond the analysis of correct responses, we were interested in the patterning of children's errors on the two production tasks as reflecting their transitional construal of the Arabic plural system. As the number of errors on the repetition task was very small, this task was excluded from the following analyses. We analyzed the errors within each morphological structure and within each task separately because the types of errors were different. Three types of errors occurred in the structured production of SFP nouns: no response, repetition of the singular target noun, and erroneous BP noun (e.g., *ħumra:n* 'donkeys' instead of *ħami:r*). The seminatural production of SFP nouns revealed the same types of errors. However, the singular target noun error was not a mere repetition of the experimenter's singular target, but the outcome of spontaneous production. BP nouns stimulated four error types: no response, singular noun, erroneous SFP noun (e.g., *kundara:t* 'shoes' instead of *kana:der*), and erroneous BP noun (e.g., *sfu:ni* 'ships' instead of *sufun*).

The two morphological structures elicited a different number of erroneous responses. Only half of the children produced errors on SFP targets, whereas

Table 6 Mean percent of SFP errors by morphological structure and task

	Structured Production $N = 18$ Error Type			Seminatural Production $N = 18$ Error Type		
Age Group	No Response	Singular Target Noun (Repetition)	Broken Plural	No Response	Singular Target Noun (Spontaneous Production)	Broken Plural
3–4	0	50.00 (50.00)	50.00 (50.00)	0	57.14 (53.45)	42.86 (53.45)
5–6	0	87.50 (35.36)	12.50 (35.36)	05.83 (12.45)	84.17 (32.02)	10.00 (31.62)
7–8	33.33 (57.74)	22.22 (38.49)	44.44 (50.92)	0	0	100 (0)

Note. *N* reflects the total number of children making errors, used to calculate mean percent errors. Standard deviations are given in parentheses.

virtually all of them produced errors on BP targets. Here we present an analysis of children's errors on SFP targets in the two production tasks, followed by an analysis of children's errors on BP targets in the two production tasks.

Regarding errors on SFP targets, 18 out of 36 children participating in our study erred on SFP targets in the structured production task: seven 3-year-olds, eight 5-year-olds, and three 7-year-olds. Similarly, in the seminatural production task, 19 children erred on SFP targets: seven 3-year-olds, ten 5-year-olds, and two 7-year-olds. Table 6 presents the distribution of SFP error types in the two tasks.

Two-way ANOVAs with repeated measures on error type (3: no response, singular noun, BP), with age as a between-subject factor, were used to analyze children's erroneous responses on SFP items in the two production tasks. In the structured production task, error type yielded a close to significant effect, $F_1(2,30) = 3.23$, $p = .054$, $\eta_p^2 = .18$, with singular responses ($M = 53.24\%$) comprising the majority of errors, closely followed by BP errors ($M = 35.65\%$), with a small number of no response errors ($M = 11.11\%$), significantly different from the singular response errors. There was no significant interaction.

In the seminatural production task, error type yielded a significant effect, $F_1(2,32) = 5.34$, $p < .02$, $\eta_p^2 = .25$, with BP errors ($M = 50.95\%$) and singular responses ($M = 47.1\%$) constituting the bulk of errors, with a tiny percentage of no response errors ($M = 1.94\%$), significantly different from both other error types. The important finding regarding errors on SFP targets in the seminatural

Table 7 Mean percent of BP errors by morphological structure and task

	Structured Production $N = 34^*$ Error Type				Seminatural Production $N = 36^*$ Error Type			
Age Group	No Response	Singular Target Noun (Repetition)	Other Broken Plural	SFP	No Response	Singular Target Noun (Spontaneous Production)	Other Broken Plural	SFP
3–4	1.19	10.22	13.03	75.56	0.93	11.91	39.82	47.34
	(4.12)	(26.34)	(19.92)	(28.83)	(3.21)	(29.11)	(25.32)	(26.07)
5–6	0	22.01	0.76	77.23	0.93	36.25	4.86	57.96
		(22.86)	(2.62)	(22.21)	(3.21)	(30.31)	(11.49)	(30.68)
7–8	0	0	32.50	67.50	4.17	0	60.00	35.83
			(42.57)	(42.57)	(14.43)		(32.29)	(34.06)

Note. *N* reflects the total number of children making errors, used to calculate mean percent errors. Standard deviations are given in parentheses.

task was the interaction of error type by age, $F_1(4,32) = 4.1$, $p < .01$, $\eta_p^2 = .34$, shown in Figure S6 of Appendix S1 in the Supporting Information online.

Bonferroni analyses showed that this interaction derives from the significant differences between the large amount of singular noun errors in 5-year-olds, versus the small number of no response or BP errors in the same group; and from the difference between the many singular noun errors in 5-year-olds and the absence of these errors in 7-year-olds.

In contrast with errors on SFP targets, the analysis showed that more errors occurred on BP than SFP targets. In the structured production task, virtually all (34 out of 36) children participating in our study erred on BP targets: all 3- and 5-year-olds, and 10 out of the 12 older group. All 36 children erred on BP targets in the seminatural production task. Table 7 presents the distribution of BP error types in the two tasks.

Two-way ANOVAs with repeated measures on error type (4: no response, singular noun, BP, SFP), with age as a between-subject factor, were used to analyze children's erroneous responses on BP targets in the two production tasks. In the structured production task, error type yielded a significant effect, $F_1(3,93) = 52.09$, $p < .001$, $\eta_p^2 = .63$, with erroneous SFP responses ($M = 73.43\%$) comprising the overwhelming majority of errors, significantly more than all other error types: BP errors ($M = 15.43\%$) and singular noun errors ($M = 10.74\%$), both significantly differing from the no response category ($M = 0.4\%$). No significant interaction was found.

In the seminatural production task, error type also yielded a significant effect, $F_1(3,99) = 19.55$, $p < .001$, $\eta_p^2 = .37$. Here too SFP errors ($M = 47.05\%$) were the majority, and they did not differ from BP errors ($M = 34.89\%$). The other two error types—singular responses ($M = 16.05\%$) and no response ($M = 2.01\%$)—again significantly differed from the two other error types and from each other. Here too there was an interaction of error type by age, $F_1(6,99) = 6.8$, $p < .001$, $\eta_p^2 = .29$ shown in Figure S7 of Appendix S1 in the Supporting Information online.

The post hoc analysis showed that one source of this interaction derives from the small number of no response errors in all age groups. In the 3-year-olds, errors were divided between SFP and BP, with few erroneous singulars; in the 5-year-olds, the major error category was SFP, with more singulars than BP; and in the 7-year-olds, the largest error category was BP, and a second large category was SFP.

Discussion

Children's acquisition of the plural noun system of Spoken Arabic has not been the topic of much empirical research (however, see Ravid & Farah, 1999; Ravid & Hayek, 2003). Plural nouns are of particular interest here both as a universal and early-acquired inflectional system and as a testing ground for differing models of inflectional acquisition in various languages. In this context, this study further considers, and for the first time, the role in acquisition of two critical facets of the notion of frequency in a Semitic language—children's familiarity with specific singular nouns, on the one hand, and the overall frequency of plural patterns, on the other. Both factors not only made differential impact on the acquisition of SFP versus BP plurals, but also interacted significantly on BP acquisition, as discussed below.

The current study is a systematic analysis of the acquisition of the plural system among 3-, 5-, and 7-year-old native speakers of Palestinian Arabic spoken in Israel. From a developmental point of view, this study provides important information on Arabic plural acquisition beyond the early preschool years. The general developmental picture provided by this study shows that substantial learning of the Palestinian Arabic plural system takes place between the ages of 3 and 8, with significant gains between the three age groups studied. We found that the locus of developmental change occurs in preschoolers ages 5–6. However, the oldest age group (7–8 year olds) has not yet reached complete mastery of noun plurals though it has made considerable progress, especially on SFP plurals. Studying plural acquisition in Arabic is particularly revealing,

given the two different morphological structures that comprise the Arabic plural system. This made it possible to investigate the impact of linear (sound) versus nonlinear (broken) plurals—focusing on sound feminine plurals, given the scarcity and semantic specificity of sound masculine nouns in early child Arabic (Ravid & Farah, 2009). From this perspective, generally speaking again, the SFP noun plurals always yield higher scores than the BP plurals, reflecting their higher structural transparency (Ravid & Hayek, 2003). By age seven, SFP plurals have reached 90% criterion on production, whereas learning is still under way for BPs, as evidenced by the 70% success on the two production tasks.

Furthermore, knowledge of the Palestinian Arabic plural system was investigated using different elicitation tasks. Not only did we test repetition versus production, but we also tested plural production innovatively, exploring children's knowledge both in a strictly structured experiment and in a seminatural context. From a task-oriented perspective, the repetition task yielded the highest scores, as expected. We found that 3-year-olds were already capable of repeating both SFP and BP items with close to ceiling levels (Table 1, see also Figure S1), and by age 5 they reached 100% on both morphological structures. We interpret these results to reflect the already well-established representation of the overall plural system in preschool Palestinian-Arabic-speaking children. In contrast, both production tasks outlined incremental developmental progression in children's performance from the youngest to the oldest group. Not only did the production tasks show lower scores than the repetition elicitation, they also revealed that the two plural morphological structures have different developmental trajectories. Thus, the rest of our discussion will address the structured and seminatural tasks exploring the development of plural formation in Palestinian Arabic.

Production of SFP and BP Structures Across Childhood Years

Interesting differences emerged between SFP and BP structures when viewed through the prism of development and task requirement. Recall that structured elicitation explicitly required the pluralization of a singular noun prompt presented to the child, whereas seminatural production involved the child, in the context of a game, to name pictures with plural objects for a peer player. In general, the main findings are similar though not identical across the two elicitation methods. In both production tasks, we found that SFP yielded many more—in structured production, twice as many—correct responses than did BP nouns. Moreover, on both production tasks, SFP plurals started rather high

in 3-year-olds and reached almost ceiling in 7-year-olds. SFP in structured production revealed a short learning curve of about 10% gain between the 3-year-olds and the 7-year-olds, while the seminatural task condition allowed for a slightly larger gain of over 20%. In contrast, BP plurals started with extremely low scores and reaching no more than 3/4 accuracy by age 7–8; they showed a prolonged and steep learning curve of over 50% gain in correct responses across these childhood years. The error analysis supports these trends. BP target items elicited errors from almost all participants, including the oldest age group, whereas only half of the participants erred on SFP targets, the majority of whom in the two youngest groups. The few children who did make errors on SFP targets, in both tasks, produced some singular forms, in the youngest groups (Zapf & Smith, 2009), and mostly BP errors, showing these to be a robust alternative to SFP by age 7. The BP category elicited SFP errors from all age groups on both tasks, showing SFP as the default category of pluralization in Palestinian Arabic. Interestingly, erroneous BP alternatives emerged mostly in the oldest age group, testifying to the consolidation of BP patterns in school-age children. The explicit teaching of BP nouns at the elementary school grades may be one more factor contributing to this finding.

These different developmental patterns may be explained in terms of task demands and morphological structure. SFPs involve the linear suffixation of a singular stem (e.g., *ħamma:m* 'bathroom' → *ħammama:t*), whereas BPs require systematically relating a singular and a plural form with different morphological patterns (*sikki:ni* 'knife' → *sakaki:n*). These two ways of pluralizing Arabic nouns across the production tasks challenge children of different age groups in different ways. Structured production requires context-free pluralization of two morphological components. In this task, the child needs to keep in mind the singular prompt presented to her and provide its plural form. This operation assigns special prominence to the singular stem rather than to the inflected plural noun. Under these conditions, performing combinatorial formation is a manageable task even for 3–4-year-olds, especially in SFPs, because the same suffix *–a:t* attaches to any given stem, and the singular stem undergoes no substantial phonological shift under suffixation. Transparency, consistency, and salience easily foster, thus, generalizations about the structure of SFPs and performance of this type of structured production.

In contrast to SFP, performing broken pluralization requires linking the singular prompt to another, morpho-phonologically related, though distinct plural stem, in the correct broken pattern category. Under structured production, where

the singular prompt drives the formation process, stem change, usually involving internal vowel shift, appears to challenge young children, who find it easier to link transparent structures, as is the case in the SFP's linear concatenation of stem and suffix. Moreover, producing the correct BP form necessitates mapping out several different broken pattern alternatives. This requires multiple encounters with diverse plural forms so as to extract systematic generalizations about singular-plural dyads.

In contrast to structured production, the seminatural production task requires participants to name a plural entity with no singular prompt, and thus draws attention to the plural word rather than to its internal morphological components. In this task too, BPs still lag far behind the SFPs—possibly reflecting differences in size between the larger SFP and the smaller BP lexicons in child Arabic. However, the nature of the task brings out developmental differences. The SFPs, which were easy to form under structured production, need to be directly retrieved here as plurals; this was found to be slightly more difficult (though not significantly so) for all groups. Retrieving BPs, which are more wordlike, was easier in the younger age groups in this seminatural condition than under structured production (though again, the difference was not significant). It is also possible that part of the difference in performance on the structured production versus the seminatural task is attributed to the fact that the structured production task presents children with a number (e.g., "Here there is one door and here there are three?"), whereas the seminatural production task does not have this cue and hence does not equally prompt children to producing plural forms.

Despite these differences, the similar developmental trajectories revealed in the two production tasks for SFP and BP morphological structures serve to strengthen the validity of our results, while underscoring the different status of the two morphological structures in Palestinian Arabic plural acquisition.

Familiarity Effects in Pluralization

Recall that items within each morphological structure were classified into high and low familiarity based on judgments of the singular noun stem. Interesting findings resulted from the analysis of these familiarity effects. In both production tasks, singular nouns high in familiarity yielded higher correct production scores than nouns low in familiarity; and BP nouns were more affected by familiarity than SFP nouns. In the seminatural condition, SFP nouns showed no difference between high and low familiarity, while BP nouns showed a great difference in favor of familiar nouns. It is not surprising that broken plurals

should be affected by noun familiarity, because it takes a lot of linguistic experience with singular BP stems and their corresponding plural forms to extract working generalizations. We found that success is so low in 3-year-olds that familiar and nonfamiliar items do not differ. In contrast, older age groups show remarkable differences between familiar BPs, which almost triple between the two youngest groups and reach 85% in the oldest age group—and nonfamiliar BPs, which hardly increase from 3- to 5-year-olds, reaching less than 2/3 in the 7–8-year-old group. This finding was expected, as BPs are supposed to be listed in lexical memory in both singular and plural form. What was not expected, however, was the effect of familiarity on SFP items in the structured task. Familiarity crucially affects lower age groups, with more than 20% difference between SFPs whose singular form is familiar to children and those where the singular is nonfamiliar. This effect gradually disappears by 7 years of age. If we assume that inflection of regular plurals is automatic and impervious to familiarity effects, these are puzzling findings (Pinker, 1999). However, if we assume that all plural operations proceed from establishing connections between each singular and plural dyad, and extracting generalizations of different strengths depending, inter alia, on familiarity, this finding is not very surprising (Berent et al., 2002; Pinker & Ullman, 2002). In fact, these findings confirm our second prediction, deriving from the single-route model or connectionist approach, regarding the important effects of associative memory properties on all inflected items. As such, according to Mirkovic, Seidenberg, and Joanisse (2011), a quasiregular inflectional system, such as the one we have investigated, can be processed by a single mechanism compiling information from several sources (phonology, semantics, syntax, etc.) and learning the statistical mappings between them.

Frequency Effects in Pluralization

Formation of broken plurals in Arabic makes use of broken plural patterns, or pattern categories, which vary in frequency (Boudelaa & Gaskel, 2002; Ravid & Farah, 2009). In this study, we investigated the role of plural pattern frequency on the acquisition of broken plural in Palestinian Arabic. This was achieved by targeting singular nouns whose broken plural form followed high- versus low-frequency broken plural patterns. The results showed that pattern frequency was a significant factor both in the structured and in the seminatural production of nouns that varied in level of singular noun familiarity, with nouns low in familiarity pluralized significantly more accurately when the pattern they employ is a high-frequency pattern. Moreover, high-familiarity

nouns with high-frequency patterns were pluralized more accurately than low-frequency nouns with low-frequency patterns. These findings lend further support to the significance of distributional features in the acquisition of inflectional systems (Daugherty & Seidenberg, 1994; McClelland & Patterson, 2002; Plunkett & Marchman, 1993; Rumelhart & McClelland, 1986). Specifically, recent studies in the statistical learning, connectionist, single-route approach suggest that language learners (both young and mature) rely heavily on correlated information from different types of information—linguistic and distributional—in gaining command of inflectional systems like that of Palestinian Arabic (Sahni, Seidenberg, & Saffran, 2010).

Conclusion

This study sheds novel light on the acquisition of the two major plural categories in Palestinian Arabic—sound feminine plurals and broken plurals. Three major findings emerged from this study. One, we have shown that the SFP category, as predicted, dominates plural space in Arabic, especially in younger children, while knowledge of BP plurals gradually increases to occupy a central role already by young school age. In addition, this study showed, for the first time, that familiarity with singular nouns affects plural production of BP items in older age groups, and of SFP items in young age groups—testifying to the importance of word familiarity to grammatical operations in younger children. Finally, level of frequency of BP patterns was shown to impact their acquisition, endorsing the central role of morphological and distributional properties in language development. This latter finding may be used to support the separate representation of plural patterns in the Arabic mental lexicon (Boudelaa & Marslen-Wilson, 2001).

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Appendix

Sample Items

Morphological Structure	SFP	SFP	BP		BP	
Singular noun familiarity	Familiar	Non-familiar	Familiar		Non-familiar	
Plural pattern frequency			High	Low	High	Low
Example #1	طاولات ‘tables’	حامضات ‘lemons’	بواب ‘doors’	سكاكين ‘knives’	سياخ ‘knives’	سجاجيد ‘carpets’
Example #2	طابات ‘balls’	قشات ‘straws’	جراس ‘bells’	جوارير ‘drawers’	جمال ‘camels’	شواكيش ‘hammers’
Example #3	ساعات ‘watches’	مايوهات ‘bathing suits’	معالق ‘spoons’	قمصان ‘shirts’	مغاسل ‘sinks’	خرفان ‘sheep’

Note. Items are classified by morphological structure (SFP vs. BP), familiarity of singular noun (familiar vs. non-familiar), and frequency of plural pattern (high vs. low).

Supporting Information

Additional Supporting Information may be found in the online version of this article:

Appendix S1. Statistically Significant Interactions.
Figure S1. Statistically Significant Three-way Interaction of Age by Morphological Structure by Task.
Figure S2. Statistically Significant Three-way Interaction of Age by Morphological Structure by Familiarity, Structured Production Task.
Figure S3. Statistically Significant Two-way Interaction of Morphological Structure by Item Familiarity, Semi-Natural Production Task.
Figure S4. Statistically Significant Two-way Interaction of Familiarity by Pattern Frequency, Structured Production Task.
Figure S5. Statistically Significant Two-way Interaction of Item Familiarity by Pattern Frequency, Semi-Natural Production Task.
Figure S6. Statistically Significant Interaction of Error Type by Age, Structured Production Task.

Figure S7. Statistically Significant Interaction of Error Type by Age, Semi-Natural Production Task.

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