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Descriptive analysis of the development of the Arabic speech sounds among typically developing colloquial Egyptian Arabic-speaking children

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Abstract

Background: Literature only mentioned a few kinds of research that did study the development of the speech sounds of the Colloquial Egyptian Arabic dialect. Moreover, these studies focused on describing the phonological processes that children undergo in early childhood rather than describing the exact time of acquisition of these sounds. Besides, no study involved a statistically enough sample size of children across the different age ranges. Thus, this study aimed to explore the development of the Arabic phonemes among 360 typically developing Egyptian children who speak the CEA dialect, between the ages of 1.6 years and ≤ 7.4 years.

Results: The results of a 93-picture-naming test of children were analyzed. A phoneme is considered acquired when 90% of the children could properly utter the target phoneme in all word positions and mastered when 100% of children could correctly pronounce the target phoneme in all word positions. The results revealed that by the age of 1.6–2.0 years, the 6 long vowels of the CEA dialect, besides the /h/,/ʔ/, /b/, /w/, /j/, /m/, and /n/ were mastered. /t/ and /d/ sounds were mastered by the age of 2.6 years followed by /l/ sound by the age of 3.0 years. Then, /ħ/, /ʕ/ sounds were mastered followed by /k/, and /g/ at the age of 3.0 and 3.6 years, respectively. At the age of 5.0 years, /f/ sound was mastered, then /x / and /ʃ/ sounds were mastered by the age of 4.6 years, followed by /s/, /sˤ/, /tˤ/, /dˤ/. By the age of 5.6 and 6.0 years, /ɣ/, /r/, and /z/ were mastered. The /q/, /θ/, /ð/, and /ðˤ/ sounds were mastered by the age of 6.0–6.6 years. This study revealed that fricative sounds developed before the stop sounds and front stops before the back stops, and emphatic Arabic sounds were the last to develop at the school age (> 5 years).

Conclusions: This study presented a chart of the development of the Arabic phonemes of the CEA to be used as a guide to decide upon the correct trimming to start articulatory therapy for children with articulation and/or phonological disorders.

Keywords: Arabic speech sounds, Colloquial Egyptian Arabic, Arabic speech sounds development

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Background

The phonemic structure of any language consists of a set of sounds/phonemes; basically, consonants, and vowels. These sounds/phonemes are arranged to produce the different words of this language and used to convey meaning either by speech or writing. Over the first years of a child's lifetime, speech acquisition is just as important as the development of language and cognitive skills. Among the different languages, speech acquisition focuses on the development of speech perception and production by learning children the speech sounds of their language [1]. For that reason, the acquisition and the mastery of a language speech sounds is a fundamental part of the children's phonological development as well as speech development.

Regards speech development, it is associated with the development of the speech–motor skills required to produce accurate speech sounds and words. This is the function of the articulators (the front and back of the tongue, teeth, lips, roof of the mouth, vocal folds, and lungs) that work simultaneously to communicate effectively. Also, speech sound production involved a cognitive-linguistic component which is associated with learning the language phonological system and explains how sounds are connected rapidly to form words to convey meaning for communication [2]. Moreover, the regional and cultural differences influence the way people pronounce phonemes among the different languages and dialects all over the world's countries.

The phonetic inventory varies greatly among the different natural languages that information is needed about the speech sound development specifically in languages different in origin. Moreover, the development of different speech sounds is affected by different dialects in the same language. These language dialects do not exist only across countries but can also occur within the same country. One of the commonly spoken languages around the world is the English language. With all its different dialects, the development of English speech sounds differs from other languages. Comparing it to the Arabic language, previous research [3–7] also clarified the difference in the age and order of acquisition of the English speech sounds from those of the Arabic language among its different dialects [8–10], Table 1.

Arabic language, which is a Semitic language, is the first language of about 260 million people around the world. Amayreh and Dyson [9] did mention that most of the Arabic language sounds are present in the English language. However, the Arabic language is unique in having emphatic sounds [13], which comes out when the root of the tongue is retracted toward the posterior wall of the pharynx [14]. These five emphatic consonants are namely: /tˤ/, /dˤ/, /sˤ/, and /ðˤ/, which are the emphatic counterparts of non-emphatic /t/, /d/, /s/, and /ð/ sounds as well as the /q/ sound which has no non-emphatic cognate [13, 14].

Literature denoted that few studies began to emerge late in the previous century to study the development of the Arabic speech sounds among different Arabic-speaking countries such as the Jordanian-Arabic speaking children [8], Kuwaiti Arabic-speaking [12, 15], and Egyptian Arabic-speaking children [10, 15–17]. Although the results of these studies (Table 2) seem to be nearly similar, these studies had a lot of differences regarding the Arabic dialects studied and the methodology used. Besides that, neither of these studies targeted a large scale of children, nor covered all children of different ages. This unable the phoniatricains and speech-language pathologists to depend on the results of these studies while deciding the accurate timing of correction of any articulation and/or phonological error among the Arabic-speaking children who speak different dialects.

The Colloquial Egyptian Arabic "CEA" dialect or the Carine Arabic is the spoken Arabic dialect by Egyptians. CEA is also the commonly spoken and understood dialect of the Modern Standard Arabic "MSA" language among the Arabic language speakers. CEA includes 28-consonant and 6-vowel phonemes, the same as in both the Classical "Quranic" Arabic and the Modern Standard Arabic "MSA" dialects [9, 18]. However, in the CEA

Table 1 The difference in the age of acquisition of speech sounds between the English and the Arabic languages according to different English and Arabic studies

	English language phonemes*	Arabic language phonemes**
Early sounds (2 years–3 years)	Stops / p, b, g, k, d, t/ Nasals /m, n/ Fricatives /f, h/ Glides /j/	Stops / b, d, t, q, ʔ, q, k/ Nasals /m, n/ Fricatives /f, h, ʃ, ħ, ʕ/ Glides /j, l, w/
Intermediate sounds (3 years–4 years)	Fricatives /f, s, ʃ, Z/ Glides /l, w/	Fricatives /f, h, ʃ, s, x, ɣ, ʕ, θ/ Trill/r/ Emphatics /dˤ, tˤ, ðˤ/
Late sounds >4 years	Fricatives /θ, ð/ Trill /r/	Fricatives /ð/ Emphatics /ðˤ/

Adapted from *Crowe et al. [3], Dyson [4], Smit et al. [5], Dodd et al. [6], McIntosh & Dodd [7] ** Amayreh & Dyson [8], Ammar & Morsi [10], Saleh, et al. [11], and Ayyad [12]

Table 2 Results of studies done to explore the development of the Arabic speech sounds among different Arabic-speaking countries and dialects.

Authors	Sample number, nationality, age range (in years, months)	Criteria set for acquisition	Age of acquisition of the Arabic phonemes among different dialects (in years, months)	
Omar [16]	37 Egyptians, 6 months–8 years	No criteria were set	6 months–2 years	/b, d, t, ʔ, š, ʕ, h, ħ, m, n, l, w, y/
			2 years–3 years and 10 months	/k, q, g, f/
			4 years–6 years and 4 months	/s, x, ð, y, θ, ʤ, s, r/
			6 years and 5 months–8 years	/d, ð, z, t/
Amayreh & Dyson's [8]	180 Jordanians, 2 years–6 year 4 months	75% of children	2 years–3 years and 10 months	/b, t, d, k, f, ħ, m, n, l, w/
			4 years–6 years 4 months	/ʃ, x, ɣ, h, j, r/
			≥ 6 years and 4 months	/tˤ, dˤ, q, ʔ, θ, ð, ðˤ, z, sˤ, ʕ/
Morsi [17]	30 Egyptians, 2 years and 6 months–5 years	75% of children	2 years and 6 months≤3 years	All consonants are acquired except /r, dˤ, sˤ, ðˤ, z, ɣ, ʕ/
			3 years≤4 years	/r, dˤ, sˤ, ɣ, ʕ/
			4 years ≤5 years	All consonants except z, ðˤ.
Saleh et al. [11]	30 Egyptians, 1 years–2 years and 6 months	50% of children	1 year–2 years and 6 months	/b, t, d, ʔ, m, n, j, w, h, s, l/ were the most used consonants, however, only /n, d/ sounds met the criteria set for acquisition (75%)
Ammar & Morsi [10]	36 Egyptians, 3 years–5 years	75% of children	3 years–4 years	All consonants except /dˤ, z, ɣ/
			4 years–5 years	/dˤ, z, ɣ/
Ayyad [12]	80 Kuwaitis, 3 years and 10 months–5 years and 2 months	90% of children	3 years 10 months–4 years and 5 months	/b, t, d, k, g, q, ʔ, m, n, r, ðˤ, sˤ, x, ħ, ʧ, h, j, l, w/
			4 years and 6 months–5 years and 2 months	/tˤ, dˤ, f, ʃ, ɣ/
			≥ 5 years and 2 months	/θ, ðˤ, s, z, ʕ, ʤ/
Alqattan [15]	70 Kuwaitis, 1 year and 4 months–3 years and 7 months	90% of children	1 year and 4 months–2 years and 7 months	/ʔ/, /n/
			2 years and 7 months–3 years and 3 months	/k/, /m/, /b/, /h/, /l/, /w/
			3 years and 3 months–3 years and 7 months	/t/, /d/, /g/, /f/, /s/, /j/

dialect, the sounds /ʒ/ and /ʤ/ are more frequently replaced by the sound /g/. Another dialect difference is that the CEA frequently replaced the emphatic sound /q/ and the fricative /θ/ [10] with the sound /ʔ/ and /t/, respectively. As regards the vowels, besides the basic 6 short and long vowels (/a, aː, i, iː, u, uː/) that present in Classical Arabic and MSA [18], the CEA dialect includes two allophones of the Classical Arabic vowels /a/ and /aː/, with fronted allophones /æ, æː/ occurring in most circumstances, and backed allophones /ɑ, ɑː/ occurring in the vicinity of emphatic consonants /tˤ, dˤ, sˤ, ðˤ, q/ and some instances of /r/ [10, 19]. Additionally, the CEA dialects include the vowels /e, eː/ and /o, oː/ which are perceived as separate phonemes rather than allophones of vowels /i, iː/ and /u, uː/, respectively [10, 18, 20].

Among the first studies of the speech sounds development of the CEA dialect is that done by Omar in 1968 [16]. The results of this study could not be generalized or taken as a representative of the development of Egyptian Arabic speech sounds. As it was only a description of random spontaneous speech samples of only 31 Egyptian children without setting any criteria of acquisition of the sounds. Somewhat later, few studies aroused and reported the speech sound development of the CEA dialect. However, these studies either focused on describing the adult phonological system [13, 21] or describing the phonological processes that children undergo in early childhood [17], rather than describing the age and order of acquisition of the CEA phonemes. Moreover, these studies only surveyed a relatively small number of children in the age range from 2.6 to 5.0 years only.

From the previous, there is a need for a chart that describes the normal age and the order of acquisition of the Arabic speech sounds of the CEA dialect. Thus, this study aims to determine the development of the Arabic phonemes of the CEA dialect among a large number of

typically developed Colloquial Egyptian Arabic-speaking children. This study included children from the age of 1.6 to ≤ 7.4 years old aiming to present a dependable chart that will guide the phoniatricains and speech-language pathologists in deciding the exact timing of intervention for correction of articulation and/or phonological errors among the Colloquial Egyptian Arabic-speaking children.

Method

Participants

This study was a cross-sectional descriptive study that was conducted in the period between September 2018 and July 2020. This study included 360 Colloquial Egyptian Arabic-speaking children aged between 1.6 years and ≤ 7.4 years old. The participated children represented different social classes and were selected randomly from schools and nurseries of Cairo, Egypt. They were divided into 12 age groups, with 30 children in each group. All children were native Egyptian Arabic speakers of Egyptian parents and lived in Egypt since birth. A detailed medical history and clinical examination were taken from the children's parents to ensure the fulfillment of the inclusion criteria. Children selected have an average IQ and normal mental age as assessed by the screening test of the Stanford-Binet intelligence scale, 5th edition [22]. Children selected have within normal language age as assessed by the Modified Preschool Language Scale—4th edition (The Arabic version) [23]. Accordingly, children with evidence of subnormal mentality, language and/or speech delay, or with any bite anomalies (by oral examination) that could hinder the articulation were subsequently excluded from the study.

Parents of children involved in this study have given their informed consent, and the study protocol has been approved by the Ain Shams Institute's Ethical Committee of Human Research.

Method

The age and the order of development of the Arabic phonemes among the participated Colloquial Egyptian Arabic-speaking children were assessed by a picture-naming test prepared for this study, Appendix 1. This test involves 93 pictures that elicit target single words by asking children to name their pictures. The child is given 1 point for every target phoneme s/he pronounced correctly, and zero for each incorrect pronunciation. If the child did not name the picture spontaneously, the examiner gave him/her additional cues in form of questions, prompts, or the child was asked to repeat the word after the examiner who pronounced the word at normal pitch and loudness. The words list of this test covers all 28 consonants and 6 long vowels (/æ:/, /ɑ:/, /i:/, /e:/, /o:/, /u:/) that appear in the CEA dialect. Short vowels were not assessed in this study as in Arabic, short vowels are not presented by phonemes. Short vowels are presented by marks (/fatħah/, /kasrah/, and /d ammah/) on the written letters. These short vowel-marks represent the English vowels (/a/, /i/, /o/). For this reason, only the development of the long vowels that present in the CEA was investigated.

Each consonant phoneme was presented by 3 words that involve the phoneme in the initial, medial, and final positions of a word. As regards the long vowels, each of them was presented by one monosyllabic CVC word/picture. The test words were selected from the first words acquired by children from the age of 1 year and the high-frequency words commonly used early by the Colloquial Egyptian Arabic-speaking children. The test words were all nouns (not verbs) and presented by familiar pictures.

Before the application of this test on the selected study sample, a pilot study was conducted on 30 typically language developed Egyptian children, who speak the CEA dialect. They were selected randomly at the same age as the study sample, between 1.6 and ≤ 7.4 years to ensure that the selected words used were easily pronounced and their pictures were easily recognized by the children. It was found that most children had no difficulty in recognizing any of the selected words/pictures.

The picture-naming test was applied by an Egyptian Arabic native speaker phoniatrician who had 5 years' experience in the field of phoniatrics. Children's responses to the test questions were audio-recorded. The audio-recorded results were presented to three phoniatricains of over 15 years' experience in the field of phoniatrics who shared together in the analysis of each response in the same session. Scores given to each child were based on the total agreement of the three examiners.

Data management and analysis

The recorded results of the 93 responses to the picture-naming test were analyzed to detect the age and the order of acquisition and mastering of the target consonants and vowels, respectively. Two criterion levels for determining the age of acquisition and the age of mastering phonemes were settled. A consonant phoneme is acquired when 90% of children in the examined age group could utter it correctly in all word positions (initial, final, medial). While when all the children (100%) in the target age group could properly utter the target phoneme in all positions, this was considered the age of full mastering of this consonant phoneme. For each long vowel, it is considered acquired and mastered when the CVC word representing each could be uttered correctly by 90% and 100% of children in the examined age group, respectively.

Statistical analysis was performed using the SPSS software (version 24). The distribution of the variables was performed according to the type of data obtained for each variable.

Results

360 typically developed Colloquial Egyptian Arabic speaking children were participated in this study, with a total male to female ratio of 1:1.7. The descriptive data of the participated children including the chronological age, gender ratio, IQ, and total language age were reported in Table 3. Charts present the percentage of children in each age group who correctly pronounced each of the Arabic phonemes of the CEA dialect in the 3-word positions (for consonants) and the one word presented for each long vowel were presented in Fig. 1.

In this study, the analysis of the scores of the picture-naming test indicated that all children between 1.6 and < 2 years mastered the pronunciation of all the 6 Egyptian Arabic long vowels (/æ:/, /ɑ:/, /i:/, /e:/, /u:/, /o:/) as well as the consonants sounds (/b/ /h/, /w/, /j/, /ʔ/, /m/, /n/) in all word positions. /t/ and /d/ sounds are considered phonemes to be acquired by the age of 1.5 to < 2 years (group 1) as 90% of children in this group pronounced them correctly. By the age of 2 to < 2.6 year, /t/ and /d/ were mastered. The /l/ sound started to be acquired and added to the children's repertoire by the age 2 to < 2.6 years; however, it was mastered by the age of 2.6 to <3 years. As the children increases in age the consonants (/ħ/, /ʕ/, /g/, /k/, /f/, /ʃ/, /x/, and /s/) were added to their repertoire respectively, till the age of 5 to 5.6 years, these consonants were mastered. According to the criteria set for phonemes acquisition and mastering, less than 60% of children in the age groups 1 to 6 could correctly utter the consonants /ɣ/, /z/, /r/, /θ/, and /ð/ together with the emphatic Arabic sounds. These phonemes started to be acquired by the age of 4 to <4.6 years (group 7) with /sˤ/, /ɣ/ sounds are the first followed by /z/, /r/, and the emphatic /tˤ/ and /dˤ/ sounds by the age of 4.6 to <5 years, then consonants /θ/, /ð/, /ðˤ/, and /q/ by the age of 5.6 to <6 years. Table 4, Figs. 2 and 3 showed the order of acquisition and mastering of the Arabic phonemes of the CEA among children who participated in this study according to the results of the picture-naming test applied to them. The analysis of the picture-naming test tasks revealed that by the age of 6≤6.6 years old (age group 9), all the phonemes became mastered (fully acquired). The last phonemes acquired were the emphatic sounds that started to be acquired by the school-age (5.6≤6 years old). Finally, by the age of 6 to < 6.6 years, all the Arabic phonemes of the CEA dialect were mastered by the participated children.

Finally, this study revealed that according to the manner of articulation, vowels, and nasals, glides are the earlier sounds to be acquired and mastered. Stops were developed before fricatives. Front stops preceded the back ones; however, the back fricatives preceded the front and the middle fricatives. The emphatic sounds that have more refined distinctive features were the last acquired and mastered phonemes, Fig. 4.

Discussion

Speech sound development in children is crucial as it reflects indirectly the phonological mastery during their language acquisition [24]. No doubt, children using the same language usually show some differences in the

Table 3 Descriptive data of the participated children in the 10 age groups, including the mean chronological age, male to female ratio, mean IQ, and mean total language age of children in each age group

Age groups (30 children in each group), age range (in years)	Chronological age (mean ±SD)	Male to female ratio	IQ* (mean ±SD)	Total language age** (mean ±SD)
Age group (1): 1 year and 6 months ≤2 years	1.43 (±0.3)	9:21	94.2 (±0.08)	1.4 (±0.18)
Age group (2): 2≤2 years and 6 months	2.35 (±0.17)	12:18	94.7 (±0.11)	2.39 (±0.23)
Age group (3): 2 years and 6 months ≤3 years	2.86 (±0.07)	12:18	96 (±0.24)	2.93 (±0.07)
Age group (4): 3 ≤3 years and 6 months	3.34 (±0.17)	12:18	97 (±0.13)	3.47 (±0.28)
Age group (5): 3 years and 6 months ≤4 years	3.84 (±0.11)	9:21	94.9 (±0.23)	3.92 (±0.09)
Age group (6): 4 ≤4 years and 6 months	4.3 (±0.2)	12:18	94.7 (±0.04)	4.53 (±0.25)
Age group (7): 4 years and 6 months ≤5 year	4.82 (±0.11)	12:18	97.4 (±0.17)	4.91 (±0.16)
Age group (8): 5 ≤5 years and 6 months	5.34 (±0.17)	9:21	98.2 (±0.2)	5.43 (±0.24)
Age group (9): 5 years and 6 months ≤6 year	5.69 (±0.30)	21:9	97.4 (±0.22)	5.92 (±0.16)
Age group (10): 6 ≤6 years and 6 months	6.27 (±0.19)	9:21	98.6 (±0.09)	6.43 (±0.19)
Age group (11): 6 years and 6 months ≤7 years	6.81 (±0.13)	6:24	98.8 (±0.62)	6.94 (±0.17)
Age group (12): 7 year ≤7 years and 4 months	7.33 (±0.3)	10:20	98.5 (±0.3)	7.41 (±0.11)

*IQ assessed by the screening test of Stanford-Binet intelligence scale, 5th edition [19], and **Total language age by the Modified Preschool Language Scale—4th edition (The Arabic version) [20]

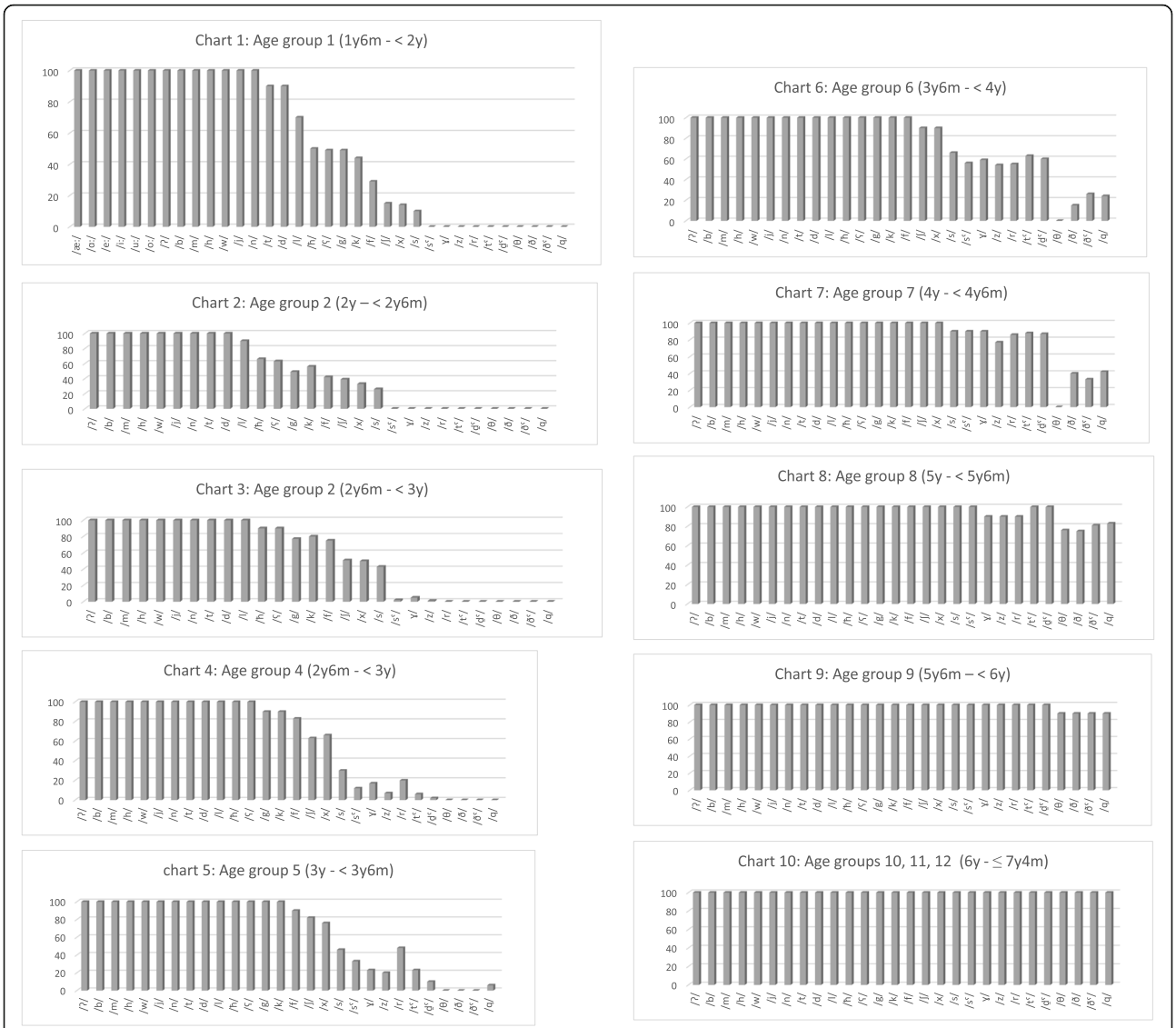

Fig. 1 The age and order of mastering of the speech sounds of the Colloquial Egyptian Arabic phonemes among the Egyptian Arabic-speaking children participated in this study

development of their phonetic inventory. Some of these differences also seem to rest on different strategies adopted by children in acquiring adult speech sounds, whatever the ultimate source of such strategies may be [25]. Such individual strategies include preferences for certain sounds, sound classes, or features (favorite sounds); however, whatever these individual strategies are, the acquisition of these speech sounds occurs ultimately in the same age range and by almost the same order among children using the same language. The need for establishing a normal chart with the exact age and order of development of the Arabic phonemes among the Colloquial Egyptian Arabic-speaking children was the motive for this study. Although this current study is not the first nor the only one that studied the development of the Arabic speech sounds of the CEA dialect, it presented a real confident chart that phoniatricains and speech-language pathologists could depend on while dealing with Egyptian Arabic-speaking children with articulation and phonological disorders. This is because of several reasons related to the study methodology that could account for the differences between the results of this study and the other Arabic and Egyptian studies and make this current study more reliable than others.

Firstly, it should be emphasized that this study was not concerned with the different phonological processes that children undergo in early childhood and how they gradually disappear. This study is rather concerned with determining the ages of acquisition of Arabic speech

Table 4 The age and the order of acquisition and mastering of the Arabic phonemes among the colloquial Egyptian Arabic-speaking children included in this study

Age groups (age range in years)	Criteria set for phonemes acquisition	
	Acquired phonemes*	Mastered phonemes **
Age group (1): 1 year 6 months ≤2 years	/t/, /d/	The 6 long vowels (/æ:/, /ɑ:/, /i:/, /e:/, /u:/, /o:/) and the /b/, /m/, /h/, /w/, /j/, /ʔ/, /n/
Age group (2): 2≤2 years and 6 months	/l/	/t/, /d/
Age group (3): 2 years and 6 months ≤3 years	/ħ/, /ʕ/	/l/
Age group (4): 3 ≤3 years and 6 months	/g/, /k/	/ħ/, /ʕ/
Age group (5): 3 years and 6 months ≤4 years	/f/	/k/, /g/
Age group (6): 4 ≤4 years and 6 months	/x/, /ʃ/	/f/
Age group (7): 4 years and 6 months ≤5 years	/s/, /sˤ/, /ɣ/	/x/, /ʃ/
Age group (8): 5 ≤5 years and 6 months	/r/, /z/	/s/, /sˤ/, /dˤ/, /tˤ/
Age group (9): 5 years and 6 months ≤6 years	/q/, /ð/, /ðˤ/, /θ/	/r/, /z/, /ɣ/
Age group (10): 6 ≤6 years and 6 months	All phonemes were acquired	/q/, /ð/, /ðˤ/, /θ/
Age group (11): 6 years and 6 months ≤7 years	All phonemes (consonants and vowels) were mastered	
Age group (12): 7 years ≤7 years and 4 months		

*"Acquired phonemes" mean 90% of children in each age group correctly pronounced each of the Arabic phonemes of the CEA dialect in the 3-word positions (for consonants) and the one word presented each long vowel. **"Mastered phonemes" mean 100% of children in each age group correctly pronounced each of the Arabic phonemes of the CEA dialect in the 3-word positions (for consonants) and the one word presented each long vowel

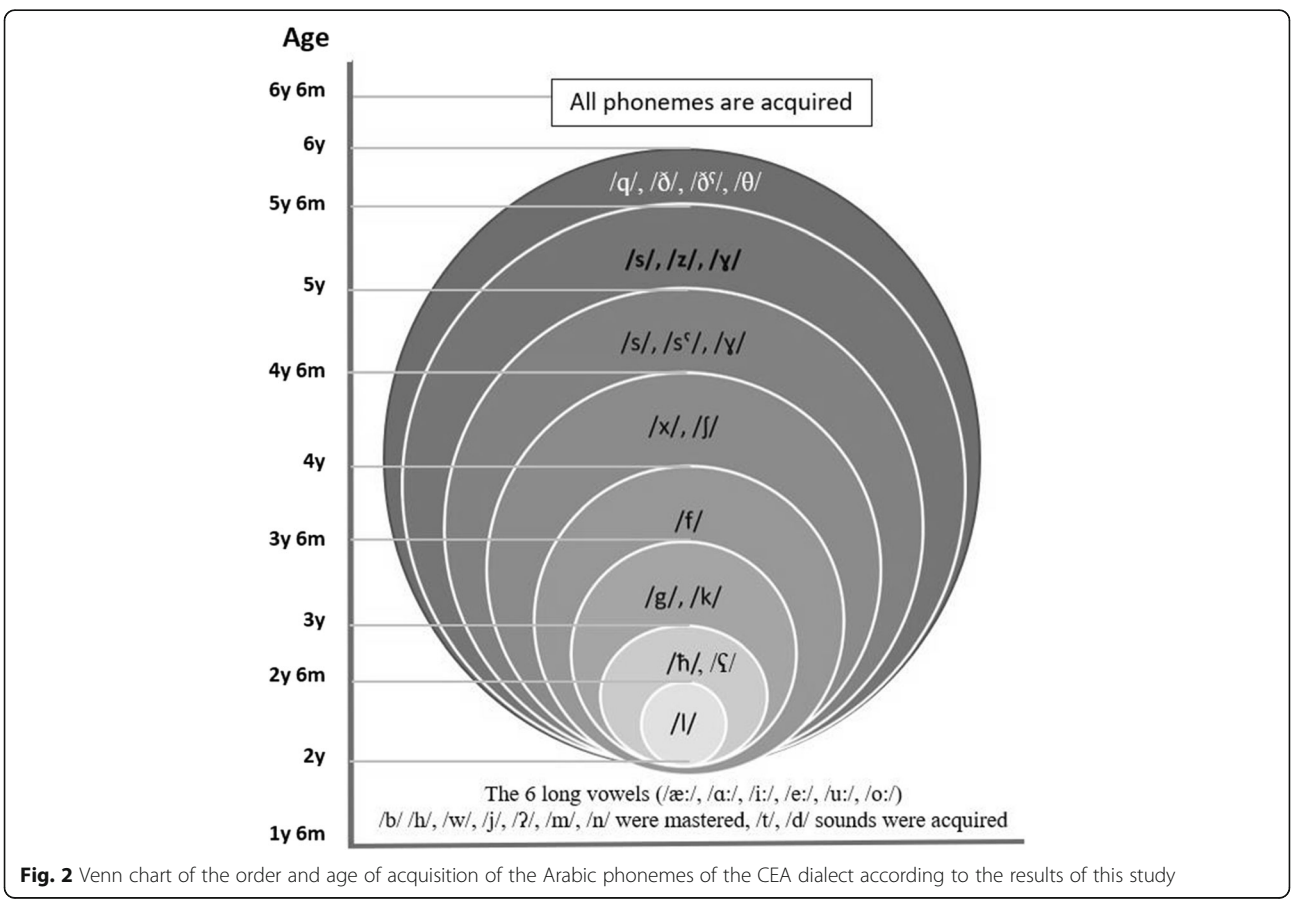

Fig. 2 Venn chart of the order and age of acquisition of the Arabic phonemes of the CEA dialect according to the results of this study

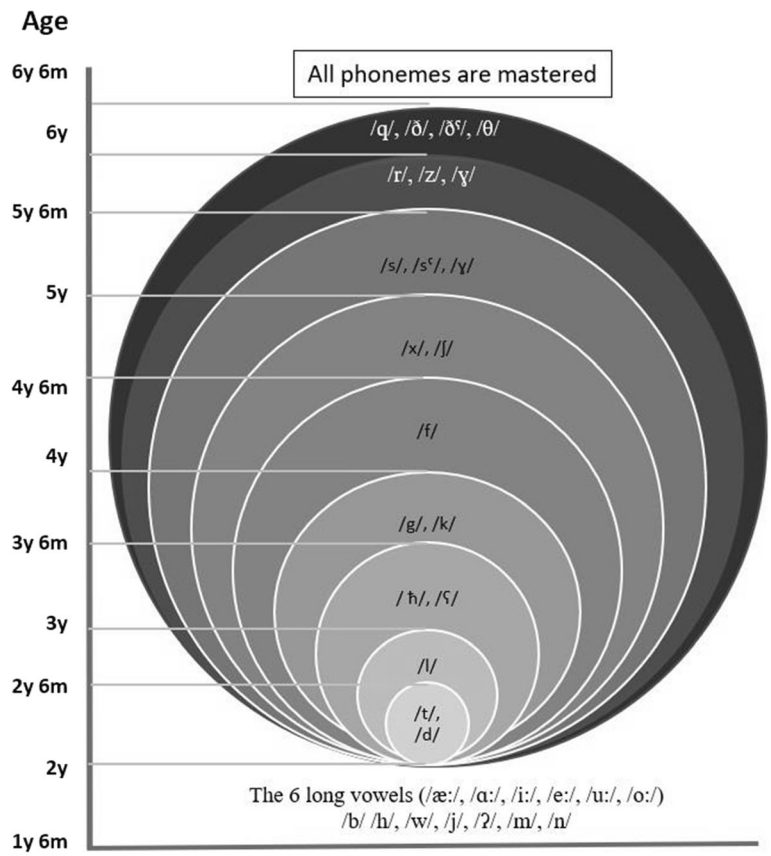

Fig. 3 Venn chart of the order and age of mastering of the Arabic phonemes of the CEA dialect according to the results of this study

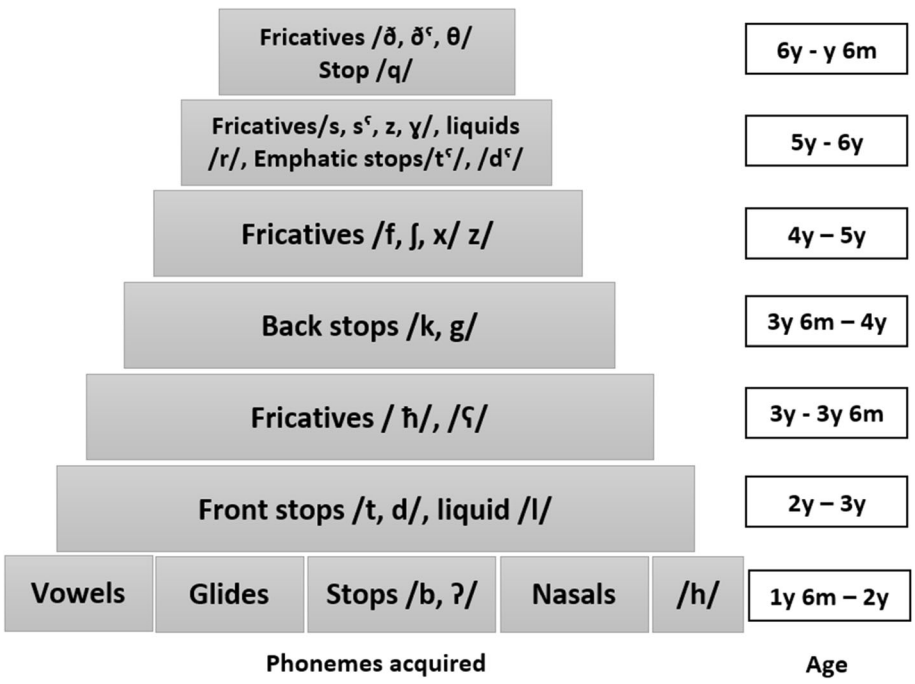

Fig. 4 The order of acquisition of the Arabic phonemes of the CEA according to the manner of articulation

sounds during the phonological development of the normal Colloquial Egyptian Arabic-speaking children. This contrasts with studies by Morsi [17] and Saleh et al. [11] who focused on studying the phonological processes (its types, development, disappearance).

Among the reasons that support the reliability of the results of this study is that it is included a large sample size of about 360 Colloquial Egyptian Arabic-speaking children. Omar's [16] study included only 31 Egyptian children aged between 2;8 and 15;0 years old (approximately one child represented each year of age). The other studies [10, 11, 17] included an average of only 30 children. Moreover, this study included 12 age groups in the age range between 1.6 and ≤ 7.4 years old, with a 6-month interval between each age group. This is unlike the previous studies that included an averagely 3 age groups with a 1-year interval between each. The wide age range and the small age interval included in this study aimed to have a closed focused observation of the children's development of the speech sounds to discover any new sound addition to the children's repertoire over a short period of their first developmental years.

Coming to the methodology, this study depended on the assessment of the speech sound development on 2 main factors. The first is that it used a picture-naming test including a word list for the 28 Arabic consonants and the 6 long vowels of the CEA dialect, without excluding vowels or any consonants like other studies such as that by Ammar and Morsi [10], Omar [16], and Morsi [17]. Moreover, the previous studies did mention that the responses to the picture-naming tasks were elicited spontaneously or through imitation and repetition of the pronounced after the examiner in case of difficulty. As it is known, imitation and repetition of pronunciation elicit 90 to 100% correct responses, and this is affecting the results. In this current study to avoid this bias, a pilot study was done before the application of the picture-naming test used to ensure that all the test words/pictures are easily recognized and pronounced by children in the same age range of the study. Besides all tested children were ensured to have normal language development by a standardized formal language test before allowing them to pass the picture-naming test, thus to avoid bias due to linguistic unawareness or difficult pronunciation/recognition of the words/pictures.

The second factor is that two criteria levels were put for determining the developmental age for each sound in this study. The first criterion is when 90% of children in the examined age group could correctly utter the target sound in all its positions; thus, the sound was considered acquired. The second criterion is when all the children (100%) in this age group could properly utter the target sound in all positions. The latter was considered as the age of full mastering, beyond which any speech error is to be considered and would signal the need for intervention. Most of the previous studies of Arabic speech sounds among different dialects used the criterion of 75% or 90% who could correctly pronounce the phoneme in any (not all) word positions as an indication for the acquisition of that phoneme. This gives a reason for the difference in the results of this study and the others. The ages of acquisition of Arabic consonant sounds reported by Ammar and Morsi [10] and Morsi [17] were found to be younger than the ages revealed in this current study. This is of course besides the small age range of children included in these two studies. Moreover, none of these studies (unlike the current one) reported the age of mastery of any of the Arabic phonemes they studied (the age at which all children in the same age range could correctly pronounce the speech sounds).

Finally, according to Jakobson's theory of phonological development, the phonemes of any language are acquired based on their distinctive features. The distribution of these phonological features among the world's languages, not only determines inventories but also dictates what kind of rules are to be expected in the acquisition [26, 27]. These distinctive features are acquired in universal sequential order and development proceeds from simple and undifferentiated to stratified and differentiated phonemes. Considering Jakobson's theory, the current study revealed that the development of all the Arabic sounds of the CEA dialect shows a linear trend where vowels were earlier to be acquired and mastered by the participated children. This is because the first feature contrast acquired according to Jakobson is that which differentiates between consonants and vowels. Also, among the early phonemes acquired and mastered by the Colloquial Egyptian Arabic-speaking children are the /b/, /ʔ/, /m/, /j/, /w/, /n/, and /h/ sounds, followed by /t/, /d/, and /l/ sounds. The explanation is that the second feature the child acquires is that differentiating between the oral and nasal sounds starting with bilabials (/m/ sound is nasal versus the oral sound /b/, both are bilabials). This is followed by acquiring the contrast features of the labial and dental sounds, adding /t/, /d/, and /n/ to the child's repertoire. After that and according to Jakobson too the child's consonant and vowel systems continue to diversify and differentiate as the child learns new feature contrasts. However, features necessary to differentiate stops, nasals, bilabials, and dentals are mastered earlier than those used to differentiate fricatives, affricates, and liquids, with back consonants proceed front consonants, and voiceless stops acquired before voiced stops according to Jakobson's principle of maximal contrast [26, 27].

Conclusions

This work presented a chart of the normal ages expected for the development of the Arabic phonemes among the Colloquial Egyptian Arabic-speaking children. This study yielded that the CEA speaking children at the age of 1.6 ≤ 2 years mastered the 6 long vowels of the CEA dialect, besides the /b/, /ʔ/, /m/, /j/, /w/, /n/, and /h/ sounds, followed by the /t/ and /d/ sounds at the age 2 ≤2.6 years old. The /l/ sound was mastered by the age of 2.6 ≤ 3 years followed by /ħ/, /ʕ/, and /k/, /g/ sounds by the ages 3 ≤3.6 years and 3.6 ≤4 years, respectively. At the age of 4 ≤4.6 years, /f/ sound was mastered by /x / and /ʃ/ sounds at the age of 4.6 - < 5 years. Then, /s/, /sˁ/, /tˁ/, /dˁ/ by the age of 5 - <5.6 years, followed by /ɣ/, /r/, and /z/ at the age of 5.6 ≤6 years. Finally, the /θ/, /ð/, and the emphatics /q/ and /ðˁ / were mastered by the age of 6 ≤6.6 years.

Recommendations

The data of this study could be used as a guide to detect and treat children with articulation/phonological disorders who are lagging the normal development of the Arabic phonemes of the CEA dialect.

Appendix 1

The picture-naming test (pictures/words list) was used in this study to determine the acquisition of the Arabic phonemes among the participated Colloquial Egyptian Arabic-speaking children.

Abbreviations

CEA: Colloquial Egyptian Arabic; MSA: Modern Standard Arabic; CVC words: Consonant-vowel-consonant words

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Authors' contributions

MM collected independently the study data from the participated selected children. DR, MK, and MH analyzed the collected data and interpreted these data. MK was a major contributor in writing the manuscript. The authors read and approved the final manuscript.

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Availability of data and materials

The datasets used and/or analyzed during the current study are available from the corresponding author on reasonable request.

Declarations

Ethics approval and consent to participate

Informed written consent was obtained from all parents of the children before enrolment in the study, and the study protocol has been approved by the Ain Shams Institute's Ethical Committee of Human Research in October 2017. The committee's reference number is not available.

Consent for publication

Not applicable.

Competing interests

The authors declare that they have no competing interests.

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