

ORIGINAL ARTICLE

Speech Sounds Acquisition Evaluated by Speech Sound Development Test (SSDT) in Turkish-Speaking Children

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The aim of this study is to provide normative data regarding the age of consonant-acquisition in normally developing children. A total of 753 children between 1 and 7 years of age were selected from seven different regions throughout Turkey. For 1-year old children, the spontaneous sound expressed (spontaneous speech) was recorded. The Speech Sound Development Test (SSDT) was applied to children within the age-range of 2-7 years old. Classifications of 'acquiring tested sound' and 'completing development' were based on 'pass criteria 75%' and 'criteria 90%', respectively. It was determined that children between 1 and 2 years of age acquired the sounds of /b, d, t, f, d, g, γ, k, l, m, n, p, s, ʃ, t, j, z/, children at 3 years of age acquired the sounds of /h, f, v/, and children at 4 years of age acquired the sounds of /r, ∞/. However, it was revealed that the development of all sounds was being completed when the children were 5 or 6 years old.

Submitted : 04 March 2009

Revised : 02 June 2009

Accepted : 12 December 2009

Introduction

Every sound has a different age-range at which the child starts making it correctly. Norms are helpful for estimating approximately how well the child's speech sounds are developing. An age norm is only an average age at which certain behaviour occurs ^[1]. The articulation assessment examines a child's ability to produce individual speech sounds in words ^[2]. They can be evaluated in two ways: phonetic versus phonemic acquisition. The term 'phonetic' refers to speech sound production (articulatory/motor skills). The term 'phonemic' refers to speech sound use (functions/behaviour/organization of the speech sound system). Researchers need to decide whether a sound has to be produced correctly in all word positions (word-initial -medial and -final) or only in word-initial and -final positions ^[3].

Certain criteria are used to determine the age of acquisition. Ameyreh and Dyson ^[4] defined three types of acquisition ages: 'Age of customary production'

(i.e. at least 50% of the children in a certain age group produce the sound correctly in at least two positions); 'Age of acquisition' (i.e. at least 75% of the children in an age group produce the sound correctly in all positions); and 'Age of mastery' (i.e. at least 90% of the children in an age group produce the sound correctly in all positions).

The inventory of phonemes somewhat differs from one language to another. Thus, the age of speech sound acquisition can change according to different languages. Danish, German, Spanish, Italian, Portuguese, Vietnamese, and Xhosa populations would be expected to differ in language acquisition and developments.

There are many studies on this subject including Turkish children ^[5-7]. Topbas ^[7] used the 75% and 90% criteria (target sounds, at least five times in the word). San ^[5] used the 50% and 90% criteria (target sounds, initial word and final word). The 'picture-naming task' procedure was used in both tests. The children were

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asked to say the target word that was pictured; ‘what do you see in this picture?’ The pictured-word naming is effected by linguistic background, long memory and cognitive skills^[8,9]. Thus, children having phonological process/speech sound processing deviations are considered to have cognitive/linguistic-based speech sound problems^[10,11].

In this study, a different method has been used to determine the acquired sounds. We developed the Speech Sound Development Test (SSDT). SSDT is an imitative test, only requiring the child’s repetition of the stimulus word. This type of test also avoids the cross modality and cognitive aspects of pointing to a picture in response to a word. SSDT attempts to assess the ‘auditory perception and auditory sequential aspects of sound as speech’. The stimulus-word repetition is affected by auditory awareness, attention, localization, discrimination, auditory feedback, voice monitoring, sequencing and auditory processing. We tried to identify future work, and to disclose the speech sound disorders of the auditory system that could explain why some children have difficulty in auditory discrimination and phonics. Additionally, we wanted to compare the results of language/cognitive and hearing effects on sound acquisition.

The purpose of this study was to provide normative data for the acquisition of consonants on each age.

Materials and Method

Participants

A total of 753 normally-developed children between 1-7 years old were randomly selected from seven different regions of Turkey. The sample consisted of 446 boys and 307 girls. Each child underwent a pure-tone hearing screening and showed no obvious speech or language disorder during an informal conversation with the examiners. In addition, their families and teachers’ reports indicated no known speech or language disorder.

Procedure

Turkish is composed of 21 consonants and 8 vowels. Native 21 consonant phonemes of standard Turkish, in their alphabetical order, are “b, c, ç, d, f, g, ğ, h, j, k, l,

m, n, p, r, s, ş, t, v, y, z”. Vowel phonemes of standard Turkish, in their alphabetical order, are “a,e,ı,i,o,ö,u,ü”.

According to the International Phonetic Alphabet (IPA), Turkish consonants show that ‘ş’ indicates /ʃ/, ‘ç’ indicates /tʃ/, ‘c’ indicates /→/, ‘y’ indicates /j/, ‘ğ’ indicates /ɣ/, and ‘j’ indicates /α /^[12].

According to the International Phonetic Alphabet (IPA), the vowels of Turkish language show that “a” indicates /a/, “e” indicates /e/, “ı” indicates /ɣ/, “i” indicates /i/, “o” indicates /o/, “ö” indicates /œ/, “u” indicates /u /, “ü” indicates /y /^[12].

In the present study, the sounds, word or sentence samples spontaneously expressed (spontaneously produced or imitated) by 1- to 2-year-old children were recorded. The percentage of correctly expressed words was also recorded. The development of words correctly expressed by the 75% of children was accepted as ‘acquired’. It was determined that 75% of the children between 1-2 years old correctly expressed the sounds of /p, b, n, t, m, d, k, g/. The SSDT was not applied to this age group.

The SSDT was applied to children between the ages among 2- to 7-year-old. The development of 21 sounds was evaluated. The SSDT consists of 123 words used to test the 21-target consonants. The sounds, except for /b, c/, are placed in six positions within the words: [Consonant (C), Vowel (V)]; 1) One syllable word-initial (CVC), 2) Two syllable word-initial (CVCVC), 3) Two syllable word-within-word; together with one consonant (CVCCVC), 4) Two syllable word-within-word; between two vowels (CVCV), 5) Two syllable word-final (CVCVC), 6) One syllable word-final (CVC).

The speech-language pathologist, clinical audiologist, child development specialist, and kindergarten and primary school teachers were trained to ensure the consistency of the test’s application. The test was applied through visits at the children’s homes, kindergartens, and primary schools. Each child was individually assessed.

The interviewer and the child were seated side-by-side around a table in a quiet room. Direction was ‘Say’,

such as ‘Say top’. If a child failed to correctly express a consonant in the repeated-word task, he/she would be allowed for two or three extra attempts. The word expressed by the child was recorded ‘as is’. If the sound being tested existed within the expression the child mimicked, it would be accepted as acquired by the child. Incorrect expression of the word would be ignored. For example, when testing the sound of ‘p’; if he/she said ‘bop’ instead of ‘top’, the sound ‘p’ would be accepted as correctly expressed by the child. As a result, 1 point was given for correct expression of the testing sound in its own position within the word, and 0 otherwise. Articulation mistakes (omission, distortion, substitution, addition and/or incorrect sequencing of speech sounds) were ignored. The only thing that was taken into consideration was the correct expression of the testing sound.

The criteria for ‘acquiring’ and ‘completing development’ of speech sounds among 2- to 7-year-old children were as follows: the mean percentage of the expressed age-appropriate words in the six positions was determined. The percentages were between the ranges 0.25-0.74, 0.75-0.89, and 0.90-1.00. The age-appropriate words expressed by 75-89% of the children were accepted as ‘acquired’, whereas those expressed by 90% of the children were accepted as ‘completed development’.

Statistical analysis

Statistical packet for SPSS (Version 8.0) was used for statistical evaluation. “Reliability Analysis Test” was applied for Statistical Analysis for whether SSDT was reliable scale or not; and Cronbach’s Alpha value for SSDT was found.

Evaluation of the alpha values were done as below:

If the result was found as $0.00 \leq \text{Alpha value} < 0.40$, the scale was regarded as “not reliable”.

If the result was found as $0.40 \leq \text{Alpha value} < 0.60$, “low reliability” was considered for the scale.

If the result was found as $0.60 \leq \text{Alpha value} < 0.80$, the scale was regarded as “quite reliable”.

If the result was found as $0.80 \leq \text{Alpha value} < 1.00$, the scale was regarded as “highly reliable”.

Results

In the present study, the acquisition and completion of sound development was investigated among 753 normal children, consisting of 446 males and 307 females. Normative sampling of participants is shown in Table 1.

Table 1. Normative sample by age and gender in Turkey.

Age groups (years)	Boys (n)	Girls (n)	Total
1 (1;0-1;11)	31	41	72
2 (2;0-2;11)	23	21	44
3 (3;0-3;11)	99	44	143
4 (4;0-4;11)	120	86	206
5 (5;0-5;11)	116	72	188
6 (6;0-6;11)	57	43	100
Total	446	307	753

Table 2. Education level of the families

Family Education Level	Mother (n)	Father (n)
Illiterate	49	14
Primary school	232	189
Secondary and high school	80-197	95-215
College	28	52
University	95	116

Table 3. Number of subjects tested in each geographical area.

Areas	n	%
The Central Anatolia Region	384	50.9
The Eastern and Southeast Anatolia	228	30.27
The Mediterranean Area	22	2.91
The Black Sea Area	84	11.15
The Marmara Area	7	0.92
The Aegean Area	28	3.71

As seen in tables 2 and 3, participants were selected from different familial education levels and geographical areas.

The SSDT was applied to children at the ages of 2- to 7-year-old. The development of 21 sounds was assessed. We developed the SSDT, which consists of 123 words used to test the 21-target consonants. The contents of SSDT are shown in table 4. In this table, * marked sounds should be used at the end of the words. However, these sounds changed if they are used at the end of the word. “b” sound converted to / p / sound; and “g” sound converted to / k / sound. “ğ” sound (/ɣ/)

Table 4. Speech Sound Development Test (SSDT)

Consonants		One syllable word-initial	Two syllable word-initial	Two syllable word within-word together one consonant	Two syllable word within-word between two vowel	Two syllable word final	One syllable word final
IPA	TR	1 st position	2 nd position	3 rd position	4 th position	5 th position	6 th position
		<u>CVC</u>	<u>CVCVC</u>	<u>CV<u>C</u>CV</u>	<u>CV<u>C</u>V</u>	<u>CVCVC</u>	<u>CVC</u>
P	p	Pil	Patik	Yaprak	Küpe	Çorap	Cep
b	b	Bir	Balık	Abla	Abi	Torb*a	Not use
m	m	Muz	Mısır	Amca	Kemik	Lokum	Dam
f	f	Fil	Fidan	Köfte	Kafes	Keyif	Küf
v	v	Var	Valiz	Kahve	Kova	Pilav	Ev
t	t	Taş	Toka	Pasta	Kutu	Paket	At
n	n	Nar	Nane	Banyo	Çene	Balon	Kan
d	d	Dil	Dolap	Yıldız	Cadı	Stand	Ad
s	s	Sev	Sepet	Eski	Mısır	Kafes	Tas
z	z	Zil	Zayıf	Çizgi	Yazı	Deniz	Yaz
l	l	Lif	Leke	Altı	Balık	Mendil	El
r	r	Ray	Resim	Yorgan	Sarı	Nehir	Mor
ʃ	ş	Şok	Şeker	Komşu	Kaşık	Kardeş	Beş
∞	j	Jip	Jilet	Ajda	Oje	Makyaj	Bej
tf	ç	Çay	Çocuk	Kepçe	Bıçak	Ağaç	Koç
d∞	c	Can	Cami	Boncuk	Gece	Not use	Hac
j	y	Yak	Yaka	Köylü	Beyaz	Kolay	Boy
k	k	Kız	Kadın	Bekci	Sakız	Dudak	Ok
g	g	Gel	Güneş	Yenge	Ege	Çizg*i	Org
γ	ğ	Not use	İğne	Düğme	Soğuk	Kağ*ıt	Dağ
h	h	Hap	Hayır	Ahçı	Uhu	Sabah	Vah

*Marked sounds should be used at the end of the words. However, these sounds change if they are used at the end of the word. "b" sound converted to /p/ sound; and "g" sound converted to /k/ sound. "ğ" sound (/ɣ/) is not used at the end of the two-syllable words (13,14).

By SSDT, bold-written sounds were evaluated.

i*s not used at the end of the two-syllabic words ^(13,14). "ıÜüğ" (/ɣ/) in Turkish orthography, actually represents a rather weak front-velar or palatal approximant between front vowels. It never occurs at the beginning of a word or a syllable, but always follows a vowel. When word-final or preceding another consonant, it lengthens the preceding vowel ⁽¹³⁾.

As can be seen in table 5, there was a difference between the ages of acquiring sounds and completing development.

For the ages of acquiring sounds (75% of children), it was found that the sounds /b, d∞, tf, d, g, γ, k, l, m, n, p, s, ʃ, t, j, z/ were acquired at age 2, the sounds /h, f, v/ at age 3, and the sounds /r,∞/ at age 4. For the ages of completing the development of sounds (90% of children), the sounds /b, d∞, tf, d, f, g, γ, h, k, l, m, n, p, s, ∞, t, j/ were completed at age 4, the sounds /v, r/ were completed at age 5, and the sounds /z,∞/ were completed at age 6.

SSDT was found to be an extremely reliable scale (Cronbach's Alpha = 0.843).

Discussion

Our normative data showed that a lot of Turkish consonants were acquired between the ages of 1 and 4 years, with exception of /h, f, v, r/ and /r, ∞/, by 75% of the children (see table 5). The development of sounds /h, f/ is completed nearly at 4 years, of /v, r/ at 5 years, and of /z, ∞/ at 6 years. The /h, f, v, r/ and /z, ∞/ consonants may be explained by their functional load. The Turkish consonants are considered difficult. These sounds may be the knowledge of the articulatory characteristics of Turkish speech sounds (articulatory knowledge).

Due to the lack of normative studies, the results of the present study were compared with two others performed in Turkish language ^(5,7). The results up to 3 years of age were similar. However, after this age,

Table 5. Development of consonants according to age in Turkish children

%75 acquisition of speech sounds Child's Age Level (years)					%90 completed speech sounds Child's Age Level (years)				
2	3	4	5	6	2	3	4	5	6
b							b		
d [∞]							d [∞]		
tʃ							tʃ		
d							d		
g							f		
ɣ*							g		
k							ɣ*		
l							h		
m							k		
n							l		
p							m		
s							n		
ɣ							p		
t							s		
j							ɣ		
z							t		
							j		
	h							v	
	f							r	
	v								z
									∞
			r						
			∞						

*The phoneme /ɣ/ indicate /ğ/, usually referred to as yumuşak g('soft g')

there were differences in the acquisition of certain sounds regarding their order and age. These findings may indicate that up to 3 years of age, the speech sounds develop parallel to hearing and language, and after 3 years being mostly affected by the contents of language rather than hearing. The relationship between the pre-linguistic skills and the receptive and expressive languages near the 3rd birthday was analysed. In addition, early in the 2nd year, while the inventory of conventional gestures uniquely contributed to receptive language outcomes, the acts for joint attention contributed uniquely to expressive outcome. Late in the 2nd year, the inventory of consonants uniquely contributed to expressive outcome^[15].

These differences may reflect the results of language and hearing effects. That means the knowledge of the acoustic and perceptual characteristics of speech sounds (perceptual knowledge) may be affected before the 3 years of age. The deviations are considered to be in the phonological process/speech sound processing by way of hearing. The language may be affected after 3 years of age as well. The deviations are considered

to be in the phonological process/speech sound processing by language. Results should be commented as different.

Another finding determined in the present study supports the articulatory learning theory. The articulatory learning theory suggests that the sounds heard most often are acquired first^[4,11]. For instance, the sound /ɣ/ (indicated /ğ/) is widely used in Turkish. However, the sound /l/ is rarely used. Both sounds are distinguished from similar ones through hearing (sound /∞/ from sound /g/, and sound /∞/ from sound /l/). In the present study, the development of sound /∞/ was completed at 6 years of age. It is generally used at approximately 6 years of age in Turkish. The fact that it is one of the latest acquired sounds may be associated with the frequency at which it is heard.

The results of this study were compared to those of different languages regarding the acquisition age of common sounds. When children who spoke British English were compared with those, who spoke Turkish, differences were determined in both the order and age of sound acquisition. It was found that Turkish-speaking children acquire sounds, other than

/∞, f, z, v/, much earlier^[13]. When compared with Arabic-speaking children, Turkish children acquired all of the sounds at an earlier stage^[16]. When compared with Spanish-speaking children, the sounds /f, r/ were acquired at the same ages, whereas the other sounds were acquired earlier by Turkish children^[17]. When compared with Cantonese children, the /f, h/ sounds were acquired earlier by Cantonese children, whereas the other sounds were acquired almost at the same ages^[18]. These findings show that speech sound norms are sensitive to language. Thus, it is important to identify the 'ages of speech sound acquisition' during the progression of phoneme learning for each language.

Conclusion

It was determined that Turkish children follow a developmental course during acquisition of the speech sounds. In the present study, when the completion of sound development was evaluated, it was found that the sounds /p, b, n, t, j, m, d, k, g, ğ, ç, c, l, ş, f, s, j/ were completed early, the sounds /v, r/ were completed intermediately, and the sounds /z, j/ were completed late.

The findings obtained by the 'repeat word' method could be beneficial for disclosing the ages speech sounds are acquired. The SSDT may be used for children suspected of having speech sound disorders and for articulation and phonology problems. The results of this study will provide a chance to evaluate the acquired sounds of children with developmental delay. The test should be particularly useful for children who did not acquire language, but could do acoustic mimicking. An educational program can also be planned according to the child's age and the sounds that have not been acquired.

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