Review / Derleme

Phonemic analysis of Turkish monosyllabic word lists used for speech discrimination (word recognition) tests

Konuşmayı ayırt etme (kelime tanıma) testlerinde kullanılan tek heceli Türkçe kelime listelerinin fonemik analizi

Yusuf Kemal Kemaloğlu, MD.,[1] Gurbet Şahin Kamışlı, MD.,[2] Güven Mengü, MD.[3]

[1]*Department of Otolaryngology, Division of Audiology, Medical Faculty of Gazi University, Ankara, Turkey*
[2]*Department of Audiology, Faculty of Health Sciences, Ankara, Turkey*
[3]*Department of Western Languages and Literatures, Gazi University Faculty of Letters, Ankara, Turkey*

ABSTRACT

Objectives: This study aims to analyze previously published Turkish monosyllabic word lists.

Materials and Methods: In this study we analyzed the Cevanşir (1966/1967), Tan (1966), Cura (1967), Hacettepe (1969/1986), Akşit (1994) and Izmir (2010) lists for the number of meaningless words, duplications, order of the consonants and vowels and phonetic content. For the speech discrimination score test, the lists should be composed of meaningful homogeneous monosyllabic words with a phonetic/phonemic balance, which are similar in intelligibility and structure.

Results: We detected that the Cevanşir list included six meaningless and seven disyllabic words; while Cura, Tan, Izmir and Hacettepe lists had some duplication. Although consonant-vowel-consonant (CVC) was the major format used in the lists, other formats (CV, VC, CVCC) were also used in Cevanşir, Tan and Hacettepe lists. All lists had a similar consonant content: /g/, /ʒ/ and /ɣ/ presented the lowest frequency while /s/, /t/ and /r/ were the most common consonants. Among the vowels, /a/ was the most common one while /ɯ/ and /oe/ were the least common ones.

Conclusion: It is noteworthy that the six-word lists, developed by different researchers over a period of about 45 years, have very similar phonemic content, although there is no published study that reveals the phonetic or phonemic balance of Turkish as a spoken language. The major difference we noticed was about word structures; some lists included different word formats that could affect difficulty level of the sub-lists.

Keywords: Audiology; audiometry; hearing loss; speech.

ÖZ

Amaç: Bu çalışmada daha önce yayınlanan Türkçe tek heceli kelime listeleri analiz edildi.

Gereç ve Yöntemler: Bu çalışmada Cevanşir (1966/1967), Tan (1966), Cura (1967), Hacettepe (1969/1986), Akşit (1994) ve İzmir'in (2010) tek heceli kelime listeleri anlamsız kelimeler, tekrarlayan kelimeler, ünlü ve ünsüz dağılımı ve fonetik içerik açısından incelendi. Konuşmayı ayırt etme testinde kullanılan kelime listelerinin anlaşılabilirlik ve yapı bakımından benzer, fonetik/fonemik dengesi sağlanmış anlamlı, homojen ve tek heceli kelimelerden oluşması gerekmektedir.

Bulgular: Cevanşir listesinde altı anlamsız ve yedi iki heceli kelime bulunmaktaydı; Cura, Tan, İzmir ve Hacettepe listelerinde ise tekrarlanan kelimeler vardı. Listelerde genelde sessiz-sesli-sessiz (CVC) kelime yapısı olmakla birlikte, Cevanşir, Tan ve Hacettepe listelerinde diğer kelime yapıları (CV, VC, CVCC) da kullanılmaktaydı. Tüm listelerde benzer bir ünsüz içeriği vardı: /g/, /ʒ/ ve /ɣ/ en az sıklıkta, /s/, /t/ ve /r/ ise en çok kullanılan ünsüzlerdi. Ünlüler arasında /a/ en sık, /ɯ/ ve /oe/ en az kullanılanlardı.

Sonuç: Konuşma dili olarak Türkçenin fonetik veya fonemik dengesini ortaya koyan yayımlanmış bir çalışma olmamasına rağmen, yaklaşık 45 yıllık bir zaman diliminde farklı araştırmacılarca geliştirilen altı kelime listesinin oldukça benzer fonem içeriğinin olması dikkat çekicidir. Listeler arasında saptadığımız başlıca fark, kelime yapılarıyla ilgiliydi: bazı listelerde alt listelerin zorluk seviyesini etkileyebilecek farklı kelime yapıları bulunmaktaydı.

Anahtar Sözcükler: Odyoloji; odyometri; işitme kaybı; konuşma.

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Correspondence / İletişim adresi: Yusuf Kemal Kemaloğlu, MD. Gazi Üniversitesi Tıp Fakültesi Kulak Burun Boğaz Anabilim Dalı, Odyoloji Bilim Dalı, 06560 Yenimahalle, Ankara, Turkey.

Tel: +90 312 - 202 64 26 e-mail *(e-posta):* yusufk@gazi.edu.tr

Needless to say, speech is regarded as a biological system with the help of which thoughts, opinions and ideas are expressed through articulation of sounds via vocal tract and the parts of the perceptual systems in our body.[1] For 150,000 to 300,000 years it has been a major way of human communication together with jests, mimics and further sounds such as laughing, crying and screaming modeled on echoic words.[2,3]

Speech, as a main instrument of the language, is a genetically evolved human property, and spontaneously develops in the brain from the birth to the end of life. Language environment around the newborn is a major determinant for speech in hearing subjects. Therefore, the spontaneously developed language is known as mother tongue.[2,3]

Speech has been used as a stimulus for testing hearing of human beings.[4-9] As it is known, speech audiology is a way to evaluate hearing quality and quantity in addition to tonal audiometry, and very essential for hearing device fitting. The important part of the linguistic background above for otolaryngologists and audiologists is that speech audiology has been developed via national languages, which should be based on mother tongue. Because not only meaning but also suprasegmental features of the speech, such as prosody, stress and structure of the words, are effective on interpretation of the given speech samples in the brain. Hence, we could say that speech-decoding system in the brain is specific to the mother tongue.[8]

In speech audiology, monosyllabic word recognition test, as commonly known as speech discrimination score (SDS) test, is the most common and useful one for both the pediatric and adult settings.[8] For SDS testing, the lists should be composed of meaningful and homogeneous monosyllabic words, which are similar in intelligibility and structure. The sub-lists should be compatible with the phonemic balance of the standard spoken language and presented to the subjects with true pronunciation with proper suprasegmental features.[4-14]

We previously reported that seven studies, including eight Turkish word lists that were developed for speech audiology, were published in Turkish[15-22] (Table 1).[23] The studies presented their clinic efficiency even if some of them have not been in routine use of audiology departments. In the present study, we aimed at analyzing the syllable structures and the phonetic/phonemic details of the Turkish lists, which were used for SDS.

MATERIALS AND METHODS

In this study, one of seven published Turkish word lists were excluded because they were composed of only words with two syllables[18] (spondees), and remaining six lists[15-17,19-22] were analyzed for the following parameters:

1. *List structure:* Number of the sublists and repetitive words and meaningless words in Turkish were noted in each list. For checking meaning of the words, the online dictionary (Büyük Türkçe Sözlük) of Turkish Language Association (Türk Dil Kurumu, TDK) was used as a reference source.[24]
2. *Word structure:* Number of the syllables and their consonant (C) - vowel (V) formats were analyzed for each list.
3. *The phonetic structure:* Voiced and voiceless consonants in each list were analyzed as reported in the International Phonetic Association (IPA) for Standard Turkish[25] by using Speech Language and Turkish Utterance Dictionary (Konuşma Dili ve Türkçenin Söyleyiş Sözlüğü) prepared by Ergenç.[26] Further, the phonemes were also classified according to place in each word, either at the beginning (word-initial) or at the end (word-final) of the words.

For these analyses, first, all words were entered to Microsoft® Excell® for Mac 2011 Version 14.0.0 (Microsoft Cooperation, Redmond, Washington, USA) and then all mathematical calculations and drawing of the figures were done by this software.

RESULTS

As seen in Table 2, while Cevanşir list consisting of 10 sublists including 20 words in each, the remaining lists had the sub-lists of 25 words for testing SDS. While Cevanşir list included six meaningless words according to TDK dictionary, the words in the remaining lists were all meaningful; but in Cura, Tan, İzmir and Hacettepe lists, duplications of some words were seen. Among all lists, Akşit list was the only list

Table 1. Turkish word lists developed for speech audiometry

Researcher(s)	Publication year	Naming of the list in this paper
Behbut Cevanşir[15]	1966/1967*	Cevanşir list
Orhan Tan[16]	1966	Tan list
Orhan Cura[17]	1967	Cura-Cochlear & Integration lists
Serpil Kılınçarslan[19]*	1969/1986**	Hacettepe list*
Günhan[18]	1974	Günhan list
Mehmet Akşit[20]	1994	Akşit List
Serpil Mungan Durankaya et al.[21,22]	2010	İzmir List

* Cevanşir completted his dissertation study in 1996 but published in 1967; ** Hacettepe list is prepared by Rafael İsrael, Erol Belgin, Ferda Aktaş, Nevma Madanoğlu, A. Erdil in 1969, and standardized and published by Kılınçarslan in 1986.[19]

Table 2. Structural analysis of the Turkish word lists developed for speech discrimination score (word recognition) test

	Cevanşir 1966/1967	Tan, 1966	Cura, 1967 (Integration)	Hacettepe, 1969/1986	Akşit, 1994	İzmir, 2010
Number of the sublists	10	3	2	6	6	3
Number of the words in each sublist	20	25	50	50	25	50
Number of the repetitive words	1 (Şans)	12 (Ak, Al, Ay, Dal, Dam, Et, Mal, Park, Süt, Tuz, Vur, Yem)	3 (Ben, Sür, Zar)	7 (Çal, Çark, Şen, Saç, Kir, Kor, Mart)	0	2 (Del, Sık)
Meaningless words*	6 (Manş, Leyl, Lik, Lort, Silk, St)	0	0	0	0	0
The words remaining for the analysis	193	63	97	293	150	148

* According to "Büyük Sözlük" of Turkish Language Association (TDK [24]).

Table 3. Structural analysis of the words used in the Turkish word lists developed for speech discrimination score test

		Cevanşir, 1965	Tan, 1966	Cura, 1967 (integration)	Hacettepe, 1969/1986	Akşit, 1994	İzmir, 2010
Number of the syllables	Mono-	186	63	97	293	150	148
	Di-	7*	0	0	0	0	0
Word format	CVC	138	49	97	215	150	148
	CV	0	1	0	3	0	0
	VC	10	10	0	39	0	0
	VCC	0	0	0	5	0	0
	CVCC	38	3	0	31	0	0
	CCVC	7	0	0	0	0	0
	VCV	0	0	0	0	0	0
Total		193	63	97	293	150	148

* These words were monosyllabic in Turkish orthography, but uttered in two syllables (disyllabic) according to the standard spoken Turkey Turkish (see the text); C: Consonant; V: Vowel.

Table 4. Distribution of the consonants in the words, which were presented in the Turksih word lists developed for speech discrimination tests*

Consonants				Cevanşir, 1966/1967					Tan, 1966							Cura, 1967 (integration list)				Hacettepe, 1969/1986 (PB300 list)							Akşit, 1997				İzmir, 2014			
				CVC		VC	Total C-in-list		CVC		CV	VC	CVCC	Total C-in-list		CVC		Total C-in-list		CVC		CV	VC	CVCC	Total C-in-list		CVC		Total		CVC		Total C-in-list	
		L	p	B	E		n	%	B	E			B	n	%	B	E	n	%	B	E			B	n	%	B	E	n	%	B	E	n	%
Voiced	Tap	[R]	/r/	6	17	1	24	8,4	0	6	0	1	0	7	6,3	1	20	21	10,8	5	20	0	1	1	27	5,4	6	18	24	8,0	3	32	35	11,8
	Lateral Approx.	[L]	/ɫ/	1	14	0	15	5,2	0	8	0	1	0	9	8,0	0	11	11	5,7	3	13	0	2	0	18	3,6	0	6	6	2,0	0	6	6	2,0
			/l/	5	15	2	22	7,7	0	5	0	0	0	5	4,5	1	13	14	7,2	3	15	0	2	1	21	4,2	6	6	12	4,0	0	11	11	3,7
	Nasal	[M]	/m/	6	16	0	22	7,7	2	10	0	0	0	12	10,7	1	3	4	2,1	7	13	0	1	3	24	4,8	6	12	18	6,0	6	9	15	5,1
		[N]	/n/	9	23	4	36	12,6	2	1	0	1	0	4	3,6	3	8	11	5,7	6	17	0	5	0	28	5,6	6	12	18	6,0	3	18	21	7,1
	Plossives	[B]	/b/	8	0	0	8	2,8	4	0	0	0	0	4	3,6	8	0	8	4,1	22	0	0	0	1	23	4,6	18	0	18	6,0	24	0	24	8,1
		[D]	/d/	8	0	0	8	2,8	3	0	0	0	1	4	3,6	10	0	10	5,2	14	0	0	0	2	16	3,2	6	0	6	2,0	17	0	17	5,7
		[G]	/g/	2	0	0	2	0,7	0	0	0	0	0	0	0,0	2	0	2	1,0	1	0	0	0	0	1	0,2	0	0	0	0,0	1	0	1	0,3
			/ɟ/	7	0	0	7	2,4	2	0	0	0	0	2	1,8	5	0	5	2,6	7	0	0	0	1	8	1,6	6	0	6	2,0	11	0	11	3,7
	Frictatives	[C]	/ʤ/	5	0	0	5	1,7	2	0	0	0	0	2	1,8	2	0	2	1,0	6	0	0	1	3	10	2,0	6	0	6	2,0	3	0	3	1,0
		[J]	/ʒ/	0	0	0	0	0,0	0	0	0	0	0	0	0,0	1	1	2	1,0	0	0	0	0	0	0	0,0	0	0	0	0,0	0	0	0	0,0
		[V]	/v/	0	0	0	0	0,0	1	1	0	1	0	3	2,7	1	1	2	1,0	4	3	1	2	1	11	2,2	6	6	12	4,0	3	3	6	2,0
		[Y]	/j/	10	7	0	17	5,9	4	1	0	2	0	7	6,3	5	0	5	2,6	16	14	0	1	0	31	6,2	6	12	18	6,0	12	9	21	7,1
		[Z]	/z/	7	9	0	16	5,6	1	6	0	0	0	7	6,3	3	5	8	4,1	5	20	0	3	1	29	5,8	6	12	18	6,0	3	9	12	4,1
Voiceless	Frictatives	[Ç]	/ʧ/	9	0	0	9	3,1	6	2	0	0	0	8	7,1	4	1	5	2,6	14	9	0	3	1	27	5,4	6	6	12	4,0	6	3	9	3,0
		[F]	/f/	8	0	0	8	2,8	3	0	0	0	0	3	2,7	3	1	4	2,1	8	7	0	3	0	18	3,6	6	6	12	4,0	3	0	3	1,0
		[H]	/h/	5	4	0	9	3,1	2	0	0	0	0	2	1,8	2	0	2	1,0	7	2	0	0	3	12	2,4	6	0	6	2,0	9	3	12	4,1
		[S]	/s/	15	8	1	24	8,4	5	5	1	1	0	12	10,7	22	0	22	11,3	22	12	1	2	4	41	8,2	12	6	18	6,0	11	9	20	6,8
		[Ğ]	/ɣ/	0	0	0	0	0,0	0	0	0	0	0	0	0,0	0	2	2	1,0	0	3	0	0	0	3	0,6	0	0	0	0,0	0	3	3	1,0
		[Ş]	/ʃ/	5	6	1	12	4,2	1	0	0	0	0	1	0,9	4	1	5	2,6	8	16	1	3	0	28	5,6	6	12	18	6,0	3	6	9	3,0
	Plossives	[P]	/p/	5	6	1	12	4,2	1	0	0	0	1	2	1,8	2	1	3	1,5	15	13	0	2	2	32	6,4	6	12	18	6,0	3	6	9	3,0
		[T]	/t/	8	9	0	17	5,9	4	4	0	2	0	10	8,9	6	16	22	11,3	14	20	0	5	4	43	8,5	12	12	24	8,0	9	9	18	6,1
		[K]	/k/	5	2	0	7	2,4	3	0	0	1	1	5	4,5	7	5	12	6,2	20	10	0	2	2	34	6,8	12	4	16	5,3	10	6	16	5,4
			/c/	4	2	0	6	2,1	3	0	0	0	0	3	2,7	4	8	12	6,2	8	8	0	1	1	18	3,6	6	8	14	4,7	8	6	14	4,7

* Cluster phonemes were not included; C: Consonant; [L] /p/, [Letter] /phoneme/; Total C-in-list, total number of the consonants in each list; V: Vowel.

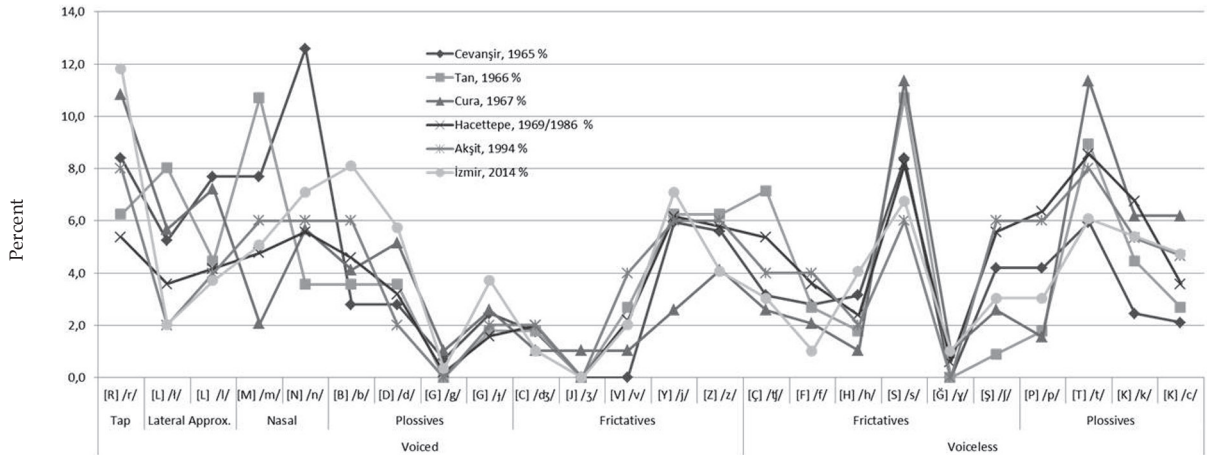

Figure 1. *The graphics of frequency ratios (%) of the consonants used in the lists (see also Table 3).*

composed of meaningful separate Turkish words without any repetition.

Further analysis was done for each meaningful word in the lists. As seen in Table 3, although all words in all lists were monosyllabic in Turkish orthography, there were seven CCVC (consonant-consonant-vowel-consonant) words in Cevanşir list, which were uttered in two syllables (disyllabic) according to the standard spoken Turkey Turkish. Hence, these words were also excluded from the following analysis.

All words in Cura, Akşit and İzmir lists were in CVC format while Cevanşir, Tan and Hacettepe lists included various monosyllabic words in different order of consonant and voiced phonemes. CVC format was still the major format (71.5%, 77.8% and 73.4%, respectively) in Cevanşir, Tan and Hacettepe lists. The second most common word structure was CVCC (consonant-vowel-consonant-consonant) in Cevanşir and Hacettepe lists (38 and 31 words, respectively); Tan list included only three words in CVCC format. Hacettepe list also included 42 words without any consonants either at the beginning (VC) or at the end (CV), while 10 VC words were used in the Cevanşir list. Tan list included one CV and 10 VC words. Further, Cevanşir list also included four words in VCC format. The ending phonemes of the words in CVCC and VCC format were classified as "cluster-phonemes", and it was found that 38, three and 36 words ending by cluster phonemes were covered in Cevanşir, Tan and Hacettepe lists, respectively.

In Table 4, distribution of all consonants (excluding those in the cluster morphology) in all lists was presented according to manner of articulation. The Figure 1, disclosed the percentages of frequencies for each consonant in the lists. As seen, /g/, /ʒ/ and /ɣ/ phonemes presented the lowest frequency in each list, while /s/, /t/ and /r/ were the most common consonants used in the lists (Table 4, Figure 1). In addition, /ɟ/, /ʤ/ and /v/ were the other phonemes that are less used in all of the lists. On the other hand, /m/, /n/, /b/, /ʧ/and /ʃ/ were the consonants that presented great variation between the lists.

The balance between the beginning and the ending consonants were presented in Figure 2. Although none of the graphics shaped by the lists revealed symmetry between the beginning and ending consonants, Hacettepe and Akşit lists appear to have reached a symmetry to some extent. In none of the lists it was noticed that all voiced plosives and some of the voiced fricatives (/ʤ/ and /ʒ/) disclosed any balance between the beginning and ending consonants.

The vowels presented almost parallel distribution in the lists (Table 5). While /a/ was the major vowel in all lists, /ɯ/ and /œ/ were the least used ones. The only inconsistency was present in /i/ in Cura list; yet its frequency was only 3.09%, it was the second most common vowel in other lists.

DISCUSSION

Speech discrimination score testing is necessary in addition to pure tone audiometry because

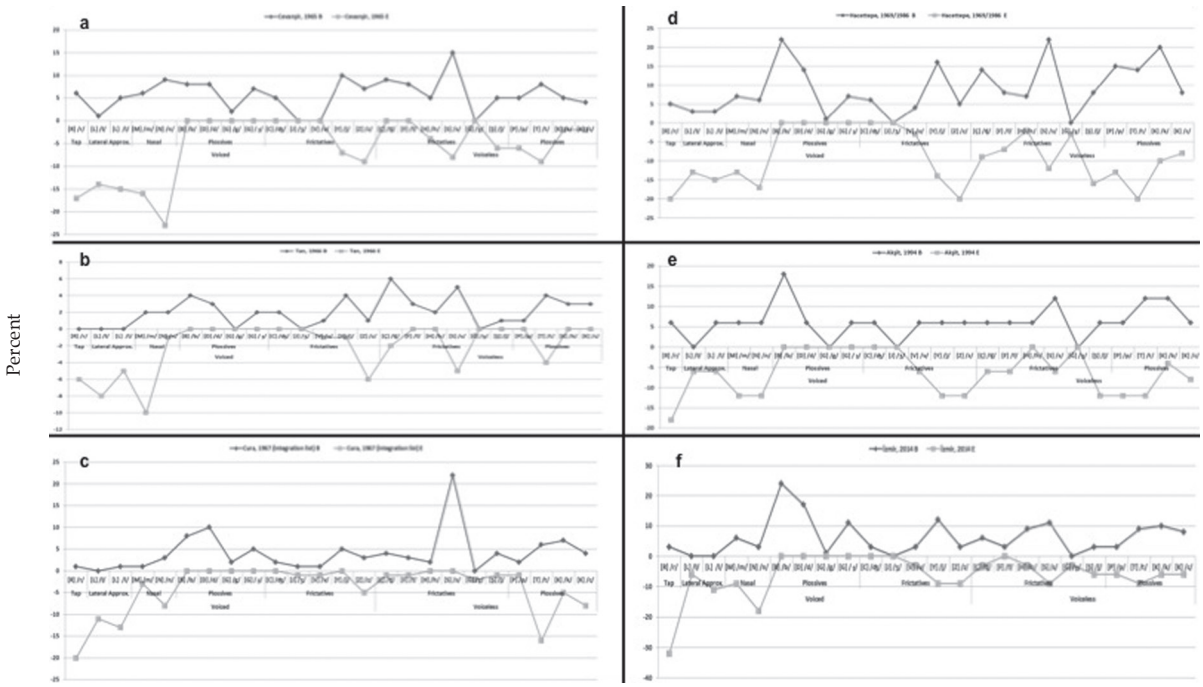

Figure 2. *The graphics presenting the frequency ratios (%) of the consonants used at the beginning (on the upper -positive- part of the x-axis) and at the ending position (on the lower -negative- part of the x-axis) of the words in Cevanşir* ***(a)****, Tan* ***(b)****, Cura* ***(c)****, Hacettepe* ***(d)****, Akşit* ***(e)*** *and İzmir* ***(f)*** *lists.*

it has been shown that discrimination of the speech sounds in the brain is a complex process, which is performed not only in the regions below the Sylvian fissure but also by the contribution of the Broca region(s) to some extent. The decoding process of speech in the brain is not only related with the amplitude, but more importantly it is a mixed function of de-coding of various frequencies in the speech sample, and subsequently but almost concurrently re-synthesizing them for "de-coding" of the articulations.[4-9,27-29] Therefore, most of the patients present hearing problems as the only difficulty in understanding speech.[8]

Frequency specific information is coded in the frequency specific regions of the cochlea, and each fiber originating from the frequency specific regions joins into the cochlear nerve in a very particular localization. Hence, when

Table 5. Distribution of the vowels in the words, which were presented in the Turkish word lists developed for speech discrimination tests*

Vowels	Cevanşir, 1965		Tan, 1966		Cura, 1967 (Integration)		Hacettepe, 1969/1986		Akşit, 1994		İzmir, 2010	
a -/a/	58	30.05	24	38.09	34	35.05	92	31.4	42	28	45	30.4
e-/e/	49	25.39	11	17.46	23	23.71	52	17.75	30	20	35	23.65
o-/o/	8	4.14	6	9.52	10	10.31	35	11.94	8	12	12	8.11
ö-/œ/	0		2	3.17	7	7.22	17	5.8	6	4	6	4.05
ı-/ɯ/	10	5.18	1	1.59	2	2.06	11	3.75	6	4	6	4.05
i-/i/	48	24.87	8	12.7	3	3.09	38	12.97	30	20	21	14.19
u-/u/	10	5.18	9	14.29	12	12.37	22	7.51	12	8	12	8.11
ü-/y/	10	5.18	2	3.17	6	6.19	26	8.87	12	8	11	7.43
Total	193	100	63	100	97	100	293	100	150	100	148	100

the nerve is pressed by any mass or lesion along its way towards the cortical centers -if the whole nerve is not damaged- some fibers of the nerves carrying some frequencies (generally higher frequencies of 4 kHz and above) of the sound or speech sample are blocked, while the rest manages to stimulate the frequency specific centers in the brain. The part of cochlear nerve extending to the brain after emerging from the cochlea is named as retrocochlear portion, and the retrocochlear pathologies are characterized by qualitative loss of some frequencies in the stimulus sample. If the test stimulus is pure tone, audiogram presents a typical descending curve in those subjects. However, the descending curves are very common but not typical to only retrocochlear pathologies. Many of the cochlear lesions, particularly presbycusis or noise-induced hearing loss, present descending curves at the audiograms.[8,29-31] Thus, speech tests are essential to differentiate cochlear sensorineural hearing loss from the retrocochlear ones. Speech tests are also very useful during the fitting to prove that the device provided enough frequency spectrums for understanding the speech in daily life.[2,4-9,29-31] In short, the clinicians need speech tests to show how the subject recognizes the words for better clinical diagnosis.

In nature of the speech tests, as a rule, the tester has to read aloud the words and the subject is expected to repeat it correctly.[8,29-31] To prevent degrading of the score due to another reason such as language barrier or misunderstanding of the words by the subject, the word lists must be in mother tongue of the subjects, and well-known words in a well-known format should be used. In 1960s, the needs for Turkish word lists were recognized. Cevanşir[15] was the first one to conduct a study about the word lists in 1965, completed in 1966 and published in 1967. Later, Tan[16] and Cura et al.[17] also followed him and prepared their own lists. Hacettepe list was developed during the same years,[19] and it has been widely used in many departments since Hacettepe University is the first school for audiology training in Turkey.[31] The graduates of Hacettepe University have spread the list in many clinics throughout Turkey. Many years later, the second generation of lists were developed by the researchers.[20-22] They claimed their lists to be better for SDS testing because they had better phonemic/phonetic balance for Turkish language and were standardized for type and degree of hearing loss. Further, Mungan[21] and Mungan Durankaya et al.[22] chose the words in respect to familiarity test.

The common point of Akşit and Izmir lists[20-22] was that these lists were composed of only words in CVC format as in the phonetically balanced word lists in English.[4-9] It has been shown that CVC is the major single-word format in Turkish.[32,33]

In the literature there is no clear support for such an assumption that a single word format and particularly CVC is better than the others. However, as postulated by Egan and others, the sublists must have equal difficulty level in terms of intelligibility and structure.[6-9,34] Hence it could be noted that a standard syllable format such as CVC, which is also very common in the mother tongue, provides better standardization for duration of the words and their suprasegmental features during pronunciation.

As reported by Kopkallı,[35] syllables of Turkish are composed of the onset and rhyme units, and the rhyme includes two parts: the nucleus and the coda. The nucleus is the most important constituent, which is always a vowel in Turkish. To explain in more detail, Turkish words are formed around a vowel (V, VC, CV, CVC, CVCC, VCC, and further CCCVCCC for the borrowed words), and the word-final consonant following the vowel is the coda. Accordingly, the Turkish word lists claimed to provide a balance between the consonants at the beginning and ending positions. However, as clearly reported by the linguistic studies, consonants at the ending position of the syllable in Turkish apply to oral non-continuants, but not to fricatives.[35-37] Therefore, use of fricatives was less than the non-fricatives at the end of the monosyllabic Turkish words in all the lists evaluated in this study (Figure 2).

The use of the cluster phonemes (CCVC at the beginning, and CVCC or VCC at the ending) is common in the English lists (as seen in Rush Hughes' PB-50 Wordlist[38]), because cluster phonemes in both positions are very common in English.[6-9,34,38] However, in Turkish cluster phonemes are rare and particularly used in word-final. The clusters in word-initial are mostly borrowings, as an example there are seven such

words in the Cevanşir list.[15] As reported by van der Hulst and van de Weijer,[36] Kopkallı[35] and Ozsoy,[37] pronunciation of the clusters in word-initial is characterized by breaking up the clusters by vowel insertion between two initial consonants (e.g. "kral", "king" in English, is pronounced as kɯral). It means that in daily speech, these words are not monosyllabic although they are written as monosyllabic according to the grammar of Turkish orthography. On the other hand, the clusters in the word-final are not rare in Turkish and the second consonant at the end is colored by the preceding vowel (e.g. /t/ of "kent", "city" in English, Hacettepe list); this is named as the mirror image situation.[35-37] We have found no study to reveal that their acoustic values are similar to the codas in CVC-words in Turkish. Furthermore, their understanding during the test through a list mostly composed of CVC-words could be misleading for the subjects. Therefore, it could be said that the use of these words during speech discrimination tests in Turkish are open to discussion.

Phonetic balance of the lists used for SDS testing is described as having phonemes within a word list represented in the same proportion as in the spoken language of the subjects.[8-11] Because of the difficulty in providing phonetic balance, the concept of phonemic balancing was introduced. It means the lists should be composed of equal number of each phoneme at the beginning and ending positions in proportion to frequency of usage.[38,39] As it is pointed out by Martin et al.,[40] the word lists that aspire to follow either phonetic or phonemic balance are traditionally referred to as PB word lists in English. It was seen that the researchers of the Turkish word lists[15-22] also claimed to follow Turkish phonetic or phonemic balance.

Standard Turkey Turkish covers 32 phonemes, symbolized by 29 letters in Turkey Turkish orthography.[25,41] Briefly, the phonemes of [g], [k] and [l] have two different phonemes that are shown by the same letter in the Turkish alphabet. Cevanşir and Cura lists clearly focused on 32 phonemes of spoken standard Turkey Turkish[15,17] as reported by IPA.[25] The Tan, Hacettepe and Akşit lists did not reveal any information whether they focused on all of the 32 Turkish phonemes.[16,19,20] On the other hand, it was noted that İzmir list was prepared for 29 letters of Turkish orthography[21,22] although they pointed out the presence of 31 phonemes in Turkish spoken language.[21] Despite these differences in the planning stage, we found that the analysis of either the second generation lists or the former ones had a similar phonemic balance with each other (Table 4, Figure 1). But the phonemic balance between consonant at the beginning and ending positions of the words was not achieved in any of the lists (Table 4, Figure 2). While frequency of some consonants (/ʒ/, /ɣ/, /ʤ/, /g/, /ɟ/) are very low (or even absent) in all of the lists (Figure 1), some vowels (/a/, /i/) (Table 5) and consonants (/r/, /s/ and /t/) (Table 4) had a tendency to be used more frequently than others. Although there were some differences in the remaining phonemes, probably due to the preparation of each study, we considered that the parallel trend seen in all lists could perhaps be related to the phonemic balance of Turkey Turkish. Further, we found that the frequencies of the Turkish phonemes that are symbolized by letters of [g], [k] and [l] were almost balanced in all lists.

This data clearly point out that all published Turkish monosyllabic lists, even if they included different word structures, are somewhat related to each other concerning the frequency of phonemes. However, we were unable to find any study presenting the phonetic/phonemic balance (phonetic/phonemic corpus) of spoken Turkish, although there were some studies presenting data of the printed materials.[32,33] That means, we are unable to say that the balance which was detected in all the lists (Figures 1 and 2) are in accordance with the real phonetic/phonemic balance of the spoken standard Turkey Turkish. The researchers reported that they used different sources to find out and follow phonetic or phonemic balance of Turkey Turkish while preparing their lists. Cevanşir and Hacettepe studies clearly presented that they mostly analyzed newspapers and other printed materials, and even TV programs to some extent.[16,19] Mungan[21] and Mungan Durankaya[22] used previous corpus studies.

On the other hand, the related English literature, especially since 1960s, began discussing the necessity of phonetic or phonemic balancing for developing an equivalent word list. Many studies[40,42-44] revealed that phonetic or phonemic balance was not necessary for a convenient word list used for SDS testing. However, as

Kirk et al.[6] pointed out, phonetically balanced lists still enjoy widespread use in both clinical and research settings because their psychometric properties have been well established.[8-11] Instead, the authors proposed that other non-auditory factors, such as subject age or language level (familiarity of the words), influence speech discrimination more.[8,9,12-14,27]

Familiarity of the words in the published lists with the exception of Izmir list[21,22] is unknown for the contemporary Turkish people, so that further research is necessary. Further, none of these lists was developed for the children, and the only study for development of Turkish pediatric word list was done by Şahin-Kamisli et al.[23] and Şahin-Kamisli.[45]

Homogeneity of speech signals in the test room is another problem. The use of recorded sound files of the lists is the easiest solution to solve the problem arising from the variable pronunciations of the testers. Otherwise the audiologists should be trained for correct Turkish pronunciation. Informative lists also include information on the suprasegmental features of each word in the lists for the testers' knowledge (e.g. "kar", snow, or "kâr", profit; "sol", left or "sol", the musical note sol).[25,26,35-37,41]

In conclusion, we could point out that although there is no evidence whether the published Turkish word lists follow a real phonetic/phonemic balance of standard spoken Turkish, all Turkish word lists that were prepared during the last 50 years are partially in accordance with each other regarding the distribution of the phonemes. Furthermore, these lists have proven their clinical value. Hence, even if they used different sources and various word formats, we could point out the presence of a special "word list balance" of Turkey Turkish, which did not compose equal numbers of all phonemes (that means, a "special balance" which is not phonemic). Frequency spectrum of this "special balance" in regarding clinical audiogram, which is known as speech banana in the studies performed in English, is still unknown for Turkish. The familiarity of the words used in the lists for contemporary Turkish people is another question.

Last of all, we assert that audiology and speech scientists still need a real word and phoneme corpus of spoken Turkey Turkish from the researchers working in the linguistic sciences.

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