



An early case of "VOT"

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Abstract

This paper focuses on an early instance of the concept of voice onset time (VOT) which is traditionally associated with the work of Leigh Lisker and Arthur Abramson in the 1960s. Evidence is presented here that the idea behind VOT – if not the name – is much older than commonly thought. A publication of an Armenian scientist who worked at the Abbé Rousselot's experimental phonetics laboratory at the Sorbonne in the late 19th century is discussed. That researcher studied several varieties of Armenian and categorized them in terms of what is nowadays called VOT. His paper can be regarded as an exemplar of "modern" phonetic thinking long before the evolution of digital sound processing.

Index Terms: VOT, kymograph, acoustic phonetics

1. Introduction

The concept of voice onset time (VOT) is among the most widely used notions in acoustic phonetics. It was designed to solve the problem of varying descriptive frameworks serving to phonetically distinguish plosives of the /p, t, k/ class from those of the /b, d, g/ class. The descriptive labels used to separate those two classes were "voiceless" vs. "voiced", "fortis" vs. "lenis", "strong" vs. "weak", "tense" vs. "lax", and "aspirated" vs. "unaspirated", to name only a few [1].

In what has ever since been considered a pioneering article, Leigh Lisker and Arthur Abramson proposed to combine the dimensions "voicing" and "aspiration" into the notion of Voice Onset Time (VOT), thus rendering the somewhat blurry and phonetically ill-defined concept of articulatory force obsolete [2]. Their definition of VOT reads as follows:

[...] we may define the amount or degree of voicing of a stop as the duration of the time interval by which the onset of periodic pulsing either precedes or follows release". (p. 387)

This concept is rather easily applicable to languages which contain a two-way distinction of plosives, i.e. /b, d, g/ vs. /p, t, k/, but it was also found to work for languages which show more than two categories. In that same article, Lisker and Abramson examined the plosive sounds of various languages, among them Eastern Armenian as an example of a three-category language.

The above-mentioned article by Lisker and Abramson is probably one of the single most cited publications in acoustic phonetics (Google Scholar alone lists 1636 citations as of March 9, 2013). VOT has been used as an experimental variable in developmental and gender studies [3], second language acquisition and bilingualism [4], and variational linguistics [5], to name only a few.

And yet, a closer look at historical phonetic articles reveals that the concept of VOT may not have been all that pioneering

at all in the 1960s. At the close of the 19th century, a young Armenian PhD student called Hratchia Adjarian carried out a small-scale study which can in retrospect be considered truly revolutionary [6,7].

His scalar definition of voicing could easily be mistaken for a quotation by Lisker and Abramson: "The voicing of a consonant is determined by the relation which exists between two points in time: the one at which the consonant is released by the expulsion of air from the mouth, or explosion, and the one at which the larynx starts to vibrate" (p. 123; translation mine, A.B.; original wording below).

This contribution focuses on Hratchia Adjarian as a researcher as well as on his acoustic phonetic study on Armenian, comparing his results to the later work by Lisker and Abramson.

2. Who was Hratchia Adjarian?

Hratchia Adjarian is probably the most famous Armenian linguist to this day. He was born in the Samatia district of what was then called Constantinople on the 8th March 1876. He studied at the Sorbonne and at the Université de Strasbourg. He earned his PhD in Paris in 1909 under the supervision of the famous dialectologist Antoine Meillet who had travelled to the Caucasus and learned Armenian in 1890 [8]. Adjarian published widely on Armenian with a focus on grammar and dialects. In fact, he is considered to be the founder of Armenian dialectology. He returned to Yerevan to teach foreign languages in 1923. He also authored an etymological dictionary of Armenian which has maintained its validity until this date. A University Institute in Yerevan is named after him. Hratchia Adjarian died on April 16, 1953 in Yerevan [9].

His stay at the Sorbonne coincided with the time when the Abbé Jean-Pierre Rousselot had just established his acoustic phonetic laboratory. It was at his laboratory at the Sorbonne that pioneering acoustic phonetic analyses were carried out [10]. One of the revolutionary devices used at the time was the kymograph. It consists of a rotating drum connected to a stylus which can in turn be activated by time signals of various sorts (cf. Figure 1). Paper blackened by candle smoke or petroleum lantern fumes is draped around the drum, and the layer of soot is removed by the stylus, eventually resulting in a white graph on black. The graph is preserved by spraying it with varnish. One of the actions to be recorded using the kymograph was the voice fundamental frequency. A second trace could be recorded using a mouth piece that would reflect the variation in air pressure over time. The experimental set-up which Adjarian used must have looked very similar to the one depicted in Panconcelli-Calzia [11], p. 36, except for the fact that he reports to have used two separate drums and later aligned the graphs.

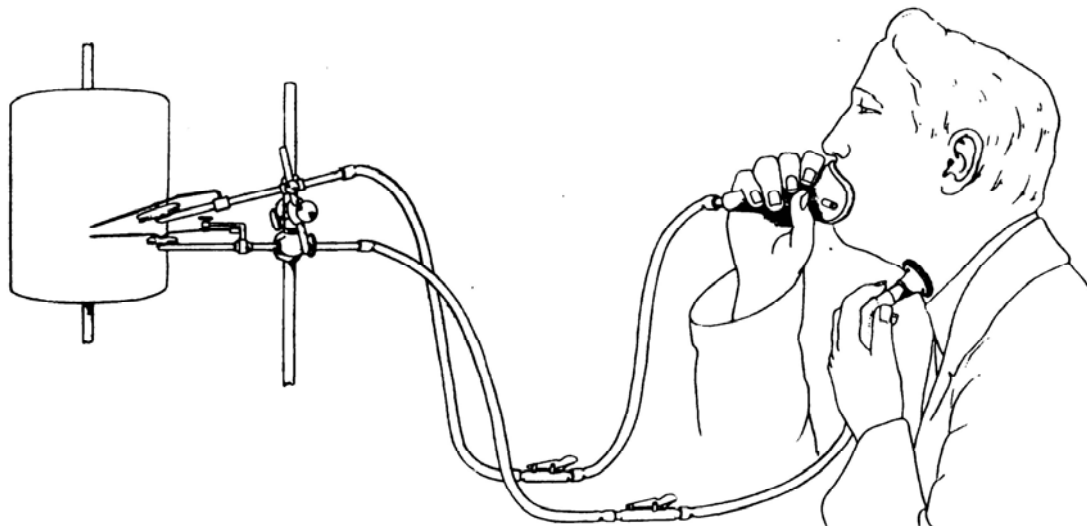


Fig. 29

**Gleichzeitige Untersuchung des Phonationsstroms bei seinem Austritt aus dem Munde
und der Tätigkeit der Stimmlippen**

Oben die Schreibkapsel nach Rousselot und unten der Kehltenschreiber nach Calzia-Schneider

Figure 1: Experimental set-up closely resembling that of Adjarian (1899); reproduced from: Panconcelli-Calzia [11] p. 36.

There is no solid proof for the notion that studying at the Sorbonne aroused Adjarian's interest in experimental phonetic research, but it is certainly in this context that the publication which is to be discussed here is to be viewed. It is a short article on the stops of Old Armenian, studied in contemporary dialects [9]. The paper was published in a journal called *La Parole ou Revue internationale de Rhinologie, Otologie, Laryngologie et Phonétique expérimentale* in 1899. What is interesting about this paper is not so much the topic as such but the methodology.

Adjarian's approach focuses on the fact that the dialects of – then – present-day Armenian differed with respect to the number of plosive categories (or phonemes) which share the

place of articulation. In terms of Lisker and Abramson [2], certain dialects were two-category varieties, whereas others were three-category varieties. The plosives of the latter can be described as voiced, voiceless unaspirated and voiceless aspirated. Unlike in other Indo-European languages, a binary distinction like +/- voiced or +/- tense will thus not suffice to fully describe those sounds. Therefore, Adjarian does not use binary categories but introduces a scalar definition of sonority instead, which he defines as follows [6]:

"La sonorité d'une consonne est déterminée par la relation qui existe entre deux moments: celui où la consonne éclate par l'effet de l'expulsion de l'air de la bouche, ou explosion, et celui où le larynx entre en vibration." (p. 123)

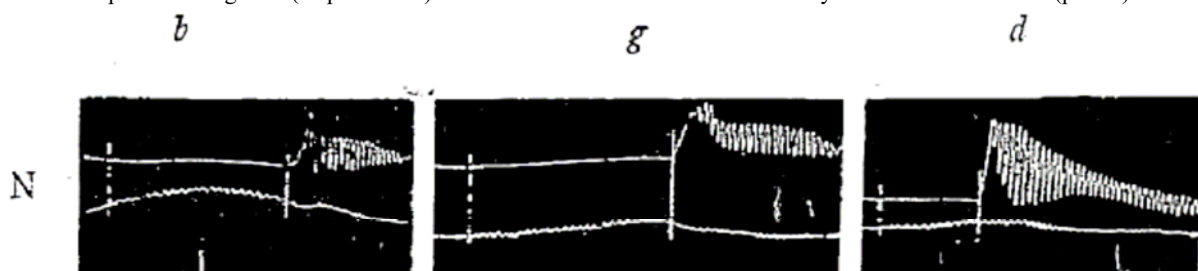


Figure 2: Kymograms of /b, d, g/ by the speaker from Noux (N) as published in Adjarian [9]¹. The solid line represents the oral explosion, the dotted line depicts the onset of voicing

¹These kymograms are actually reproduced from Rousselot [14] since the quality was much better than in the original article of Adjarian [6].

3. Findings of Hratchia Adjarian

It emerges from Adjarian's results that the dialects of Choucha, Nouxa, and – with some exceptions – Mouch are three-category varieties. Therefore, these recordings lend themselves to comparison with the Armenian speaker in the Lisker and Abramson study [2], who is described as speaking Eastern Armenian. Adjarian's article does not contain any tables but only the raw materials (kymograms) and the corresponding time scales. Therefore, measurements were carried out by this author based on the published kymograms and the scale provided in his publication¹. Since the glottal and the oral traces are aligned, the moment of the explosion depicted in the oral trace can be put in relation to the onset of glottal vibrations. The values from all three-category speakers were established. From Adjarian's own description, the speaker from Nouxa probably corresponds best to the Eastern Armenian speaker studied by Lisker and Abramson (see below).

/b/	- 90	/d/	- 60	/g/	- 105
/p/	(not rep.) ²	/t/	10	/k/	15
/ph/	45	/th/	28	/kh/	35

Table 1: Adjarian's results for the speaker from Nouxa

/b/	- 30	/d/	- 60	/g/	- 40
/p/	0	/t/	0	/k/	0
/ph/	40	/th/	40	/kh/	35

Table 2: Adjarian's results for the speaker from Choucha

/b/	- 60	/d/	- 70	/g/	- 95
/p/	0	/t/	0	/k/	0
/ph/	15	/th/	20	/kh/	40

Table 3: Adjarian's results for the speaker from Mouch

Obviously, these results have to be interpreted with caution, since only one rendition of each sound was recorded. But still, the three-way distinction between voicing lead for /b, d, g/, zero or very short voicing lag for /p, t, k/, and longer voicing lag for /ph, th, kh/ is experimentally confirmed. There is also some support for what is generally considered an aerodynamically induced universal in VOT production, i.e. that the voicing lag is longer for velars than for bilabials and alveolars. [12] On the other hand, the values for the bilabial plosives (both voiced and voiceless aspirated) seem to be unusually high.

¹ It has to be noted that all measurements taken based on the published kymograms are rather crude according to present-day standards because of the bad resolution in the printed kymograms on the one hand and the imprecise (evidently hand-written) time-scale on the other.

² According to Adjarian [6], (p.124), this sound (phoneme) does not exist in the dialect of Nouxa.

4. Comparison of Adjarian's measurements with those by Lisker and Abramson [2]

Leigh Lisker and Arthur Abramson also chose to include (Eastern) Armenian in their list of languages studied. They had only one speaker at their disposal, however, between eight and 23 tokens were analyzed. It is interesting to compare their results (all in msec) with those reported by Adjarian.

/b/	-96(- 90)	/d/	-102 (- 60)	/g/	-115 ³ (-105)
/p/	3	/t/	15 (10)	/k/	30 (15)
/ph/	78 (45)	/th/	59 (28)	/kh/	98(35)

Table 4: Lisker and Abramson's results for their Eastern Armenian speaker (Adjarian's results for the Nouxa speaker are placed in parentheses for reference).

Even though the absolute numbers seem quite different at first glance, the general tendency is very similar, including the unusually long voicing lag in the aspirated bilabial.

5. Conclusion

Adjarian's findings received considerable attention at the time. Edward W. Scripture [13] includes what is basically a literal translation of Adjarian's results section in his 1902 publication (pp.369-370). The Abbé Rousselot [14] discusses Adjarian's findings at length, even reproducing most of the graphs (pp. 502-506). Giulio Panconcelli-Calzia lists the study in his 1924 book [15], but after the 1920s, Adjarian's work seems to have vanished into oblivion.

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³ This mean value does not fall within the range given (-190 : -150 ms), so a misprint cannot be ruled out.

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