Original Study

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The Acoustics of *Contiones*, or How Many Romans Could Have Heard Speakers

Abstract: *Contiones* – assemblies during which important Roman politicians discussed the laws proposed at the People's Assemblies as well as candidates for the offices and presented their opinions to the Roman people – are considered by some scholars as one of the central institutions and rituals of the Roman Republic. Considering the role *contiones* played in the political life of the Roman Republic, we can ask how many Romans participated in them. In our paper we present results of acoustic analyses of two places at the Forum Romanum that we know were platforms for speakers at *contiones*: the *Rostra* and the podium of the Temple of Castores. The main goal of our study was to establish the maximum number of participants that could have heard speeches inteligibly. To do that we used a 3D model of Forum Romanum considering not only the geometry but also the acoustic parameters of materials used to construct the *rostra* and adjacent constructions. Based on the sound power level of a speaker and possible noise sources, on which the recipients were exposed to, we established areas where speeches could have been heard and understood. This in turn allowed us to estimate the maximum number of recipients.

Keywords: Archaeoacoustics, Forum Romanum, *Contiones*, *Rostra*, Temple of Castor and Pollux

1 Inroduction

One day in early 66 BCE Marcus Tullius Cicero ascended the speaking platform at the Forum Romanum and spoke in front of the people. Although he was an experienced and distinguished orator who had given many judicial speeches, this was the first time he had delivered a political one at the assembly. His goal was to convince the people to vote for a proposition submitted by a tribune, Caius Manilius (cf. *RE* 14, 1928, pp. 1133–1134; Broughton, 1952, p. 153) to transfer the main command in the war against Mithridates Eupator, the king of Pontus and Tigranes, the king of Armenia to Pompey the Great (Cic.*Corn*.1, fr. 16, *Fam*.1.9, *Phil*.11.18, *Mur*.34; Vell. Pat.2.33.1; Liv.*Per*.100; Asc.60, 65C; Plut.*Vit.Pomp*.30, *Vit.Luc*.35.7; App.*Mith*.97; Cass. Dio.36.42–44; Eutr.6.12.2; cf. Frank, 1914; Gruen, 1974, p. 63; Leach, 1978, pp. 74–75; Seager, 2002, p. 49). His hope was to win over Pompey's support for his future race for a consulate. Despite Pompey's high popularity following his quelling of the pirate menace, Cicero faced a difficult challenge. Manilus' notion met with fierce resistance from an influential segment of the Roman nobility. In speeches delivered before

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the people, their representatives pulled out their heaviest guns, reminding the people of Sulla and weaving a vision of tyranny and loss of freedom arising from entrusting this much power in one man's hands (Plut. *Vit.Pomp*.30.3–5; Cass. Dio.35.43.1–2). In the end, Cicero prevailed and convinced the people to support Manilius' proposition. However, before breaking the arguments of the opposition he started his speech – known as *De lege Manilia* – by acknowledging the crowd and its importance:

> Although, O Romans, your numerous assembly has always seemed to me the most agreeable body that anyone can address, and this place, which is most honourable to plead in, has also seemed always the most distinguished place for delivering an oration in, still I have been prevented from trying this road to glory, which has at all times been entirely open to every virtuous man, not indeed by my own will, but by the system of life which I have adopted from my earliest years. For as hitherto I have not dared, on account of my youth, to intrude upon the authority of this place, and as I considered that no arguments ought to be brought to this place except such as were the fruit of great ability, and worked up with the greatest industry, I have thought it fit to devote all my time to the necessities of my friends (Cic.*Man*.1).

Cicero's speeches and the context of their delivery has been the subject of many studies (see Bennett, 1995; May, 2002; Vasaly, 1996). However, there is one aspect that is usually ignored: *numerous assembly*, to cite the Arpinate himself. We know for the most part what the composition of the senate was and how many senators attended. We have considered how many of them could have participated in the debates (cf. Gruen, 1974, pp. 162–210). The *contiones* – the popular assemblies during which Roman politicians spoke before the people – were not so fortunate. For a long time they were dismissed and their role within the republican political system denied (cf. Pina Polo, 1995, p. 203). Perhaps that is why scholars have not asked the question of how many Romans could have participated in a *contio* and, more importantly, how many of them could have heard and understood the speaker.

2 *Contiones* and Propaganda

Before answering the question raised above it is necessary to explain the role *contiones* played in the Roman 'constitution'. This in turn will reveal why it is such an important question to consider.

Speaking before the people was an important part of being a Roman politician. However, it was forbidden to do so at *comitia* and *concilium plebis* – the election and legislative assemblies. *Contiones* were thus the only public assemblies that allowed Roman politicians to deliver a speech in front of the people. A *contio* was convoked by an office holder with *potestas* – a consul, praetor, censor, aedile, quaestor, *decemvir*, a military tribune with consular power, *triumvir*, dictator or, as usually happened, by a plebeian tribune – who presided over the assembly. He had the right to invite the speakers, and to set the order of speaking and time each was allowed (Pina Polo, 1995, pp. 204–206).

There were different kinds of *contiones*, among them legislative, electoral, judicial, military, and funerary (cf. Pina Polo, 1989, pp. 92–170). The legislative *contiones* were the only meetings that allowed important politicians to discuss laws proposed previously at the legislative assemblies and present their opinions to the Roman people. Some scholars (Laser, 1997, pp. 66–69, 138; Morstein-Marx, 2004, p. 124) believe that *contiones* played the key role in determining the fate of a proposed law. If a proponent noticed that the people participating in a *contio* were not in favour of the law, he withdrew it to avoid a severe loss of prestige at the People's Assembly. *Cotiones* were also a crucial part of the election of new officials. They allowed candidates to present themselves in front of the people as well as ask others – usually important figures and ex-consules – to support them publicly (Pina Polo, 1995, p. 209). Funerary or laudatory *contiones* played an important role in Roman public life and were a crucial part of funerary rites. During such events either a member of the family was allowed to publicly praise the deceased, or an official spoke on behalf of the whole community (Pina Polo, 1995, pp. 211–212). An oration of Caesar delivered at the funeral of his aunt, and the wife of the late C. Marius (Suet.*Caes*.6.1; Plut.*Vit.Caes*.5.2) is considered to be an important step in his political career (cf. Badian, 2009, pp. 20–21; Taylor, 1957, pp. 11–12; Weinstock, 1971, pp. 17–18).

Contiones can therefore be considered as one of the central rituals and institutions of the Roman Republic crucial for political propaganda or – to be more precise – personal branding (Bell, 1997, pp. 1–2, 10).

They gave the people a conceptual framework for a correct interpretation of symbolic communication embedded in material artefacts considered as media of Roman propaganda such as coins, gems, buildings and architectural decoration, and inscriptions. Since the study of target groups is an essential element of studying propaganda, attempting to answer the question of how many people could have heard the speaker becomes important.

During the Imperial era, the political *contiones* lost their importance. However, this does not mean that they have disappeared completely (Pina Polo, 1989, pp. 171–181, 1995, p. 211). Rather, they became an opportunity for the emperors to speak directly to the people of Rome. According to written sources, it was the emperors[1] who most often led the *contiones*, although sometimes consuls, praetors and *praefecti Urbi*[2] also stood before the people. In this period, on the other hand, the role of military *contiones* increased (Pina Polo, 1995, pp. 211–212).

During Republican era, different kinds of *contiones* took place in various locations. In Rome the most popular speaking platforms were: the *rostra*, the podium of the *Capitolium*, the podium of the temple of Bellona, and the podium of the temple of Castor and Pollux (Döbler, 1999, pp. 139–140; Pina Polo, 1989, pp. 182–198, esp. 183–184, 1995, pp. 212–213). Later, when the temple of Divus Iulius was constructed, it also became an important speaking platform.[3] If needed, *contiones* took place outside the *pomerium* at *Campus Martius* or in the *Circus Flamininus* (Pina Polo, 1995, p. 212). Since the two most popular speaking platforms were the *rostra* and the podium of the Temple of Castores (and after the erection of the temple of *Divus Iulius,* there were three) were located in the Forum Romanum, the political and ritual centre of the Roman Empire, we decided to study them and compare their acoustic properties.

3 Acoustic Analysis in Archaeology

Most acoustic studies in archaeology focus on analysing caves (Dams, 1984; Devereux, 2001; Díaz-Andreu & Mattioli, 2016; Till, 2014), and megalithic structures (cf. Devereux & Jahn, 1996; Fazenda, 2013; Till, 2011; Watson & Keating, 1999), as well as some monumental buildings (cf. Beristain, Coss, Aquino, & Negrete, 2002; Bilsen, 2006; Lubman, 1998, 2002). As for the classical studies, most acoustic analyses were conducted on theatres and odea (cf. Berardi, Iannace, & Maffei, 2016; Declercq & Dekeyser, 2007; Farnetani, Prodi, & Pompoli, 2008; Vassilantonopoulos & Mourjopoulos, 2003, 2009). Although the importance of an acoustic study of the Forum Romanum for better understanding of Roman oratory and the relationship between speaker and listeners has been already recognized by E. Betts (2011, pp. 128–129), little has been undertaken so far. Since the study of the audience is a crucial part of propaganda analysis (Lasswell, 1948, p. 37; O'Donnell & Jowett, 1989, pp. 295–296) we should ask how many Romans may have gathered at *contiones*,[4] and how many of them could then have heard the speaker intelligibly. This can give us the maximal range of people the speaker could have reached in one oration, and thus a principal audience exposed to the propaganda embedded in it. The results not only allow estimation of the primary range of the transmission, but they can also be a basis for further analysis of the spread of information throughout Rome.

According to Betts (2011, p. 128) today the voice of an orator can reach halfway across the length of the Forum. However, this does not take into account both background noise and acoustic properties of the surrounding environment. As we know from written sources, depending on the circumstances, the crowd could have been large or small, noisy or quiet (cf. Cic.*Mil*.1, 3.1, 4.1; Mart. 6.38.5–6 Plin. *Ep*. 9.13.19; Stat. *Silv*. 4.5.49).

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1 After Pina Polo (1995, p. 211, ann. 49) we can list: Augustus (Suet.*Tib*.21.3), Tiberius (Tac.*Ann*.4.40.7), Caligula (Cass. Dio.40.13.1), Claudius (Cass. Dio.40.10.1), Otho (Tac.*Hist*.1.90), Vitellius (Tac.*Hist*.3.36, 68), Nerva (Plin.*Pan*.8), Traianus (Plin. *Pan*.65), Hadrianus (*SHA.Hadr*.8.3), Septimius Severus (*SHA.Sev*.12,8), Severus Alexander (*SHA.Sev. Alex*. 3.4, 25.11, 57.1), Pupienus (SHA.Max.24.8, 25.5), Constantius (Amm.Marc.16.1013).

2 After Pina Polo (1995, p. 211, ann. 50) we can list: Plin.*Ep*..2.1.1, 2.1.6; Fronto.*Ep*.1.52, Tac.*Hist*.3.37; Tac.*Ann*.12.4; Coll.Avell.14.2, 29.3.

3 However, Coarelli (1985, pp. 314–320) argues the speaking platform was not an integral part of the temple but rather an independent structure in front of it.

4 As can be expected the total number of participants varied and their number depended on many factors (cf. Cic.*Mil*.1, 3.1, 4.1; Mart. 6.38.5–6 Plin. *Ep*. 9.13.19).

4 Methods

To conduct an acoustic analysis necessary to answer the question of how many Romans could have heard the speaker well enough to understand him, a 3D model of the late Republican Forum Romanum is needed. Unfortunately, we were not able to gain access to such a model before conducting this preliminary study. Thus, we had to rely on a late Imperial Forum Romanum Sketchup 3D model created by Lasha Tskhondia (Fig. 1).[5] This required a few adjustments. First, since the Republican rostra was demolished by Caesar and a new one was built in a different place (Cass. Dio 43.49; cf. Diod. Sic.12.26; Asc. *Mil*. 12), we were forced to give up the acoustic analysis of the place. In the end we decided to conduct a study of the Imperial *rostra* for comparison purposes. Second, since the Temple of Divus Iulius occupied part of the space directly in front of the Temple of Castores, thus reducing the size of the crowd, we decided to remove it from the model.
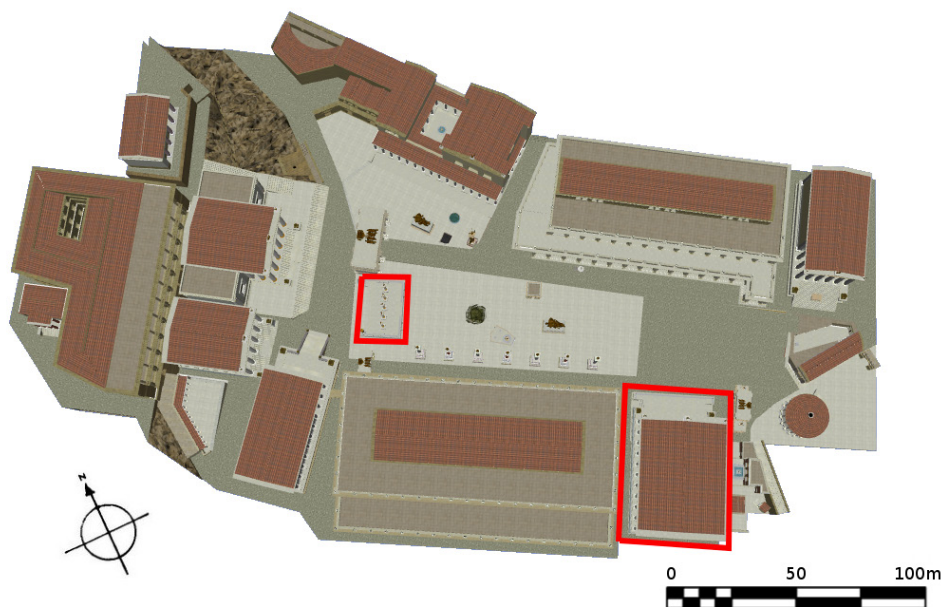
Figure 1. A top-down view of the model of Forum Romanum used in the study. The temple of *Divus Iulius* has been removed from the model, as explained in the text.

Updated 3D geometry was imported to Catt-acoustic software, where acoustic properties of surfaces were added. The most important parameter is the sound absorption coefficient, indicating how much of the sound is not reflected from the surface. Values are defined for 6 frequency bands (from 125 up to 4000 Hz) from the range of 0 to 1. The absorption coefficients used in the model are presented in Table 1.

Table 1. Sound absorption coefficients of materials used in model.

	Frequency	125 Hz	250 Hz	500 Hz	1000 Hz	2000 Hz	4000 Hz
Material name	Place of use						
Travertine	paving	0.01	0.01	0.01	0.01	0.02	0.02
Tuff	temple, podium	0.05	0.05	0.05	0.08	0.14	0.20
Ceramic	roofs	0.08	0.09	0.12	0.16	0.22	0.24
Plaster	all other	0.02	0.02	0.03	0.03	0.04	0.05

5 https://3dwarehouse.sketchup.com/warehouse/getbinary?subjectId=456438acf00cb5ad6c4e174b0cf70299&subjectClass=entity&cache=1520532602052&fn=Forum Romanum.skp&recordEvent=true&name=s18

Apart from geometry and material properties, the sound source positions and sound power spectrum was defined. Two independent simulations were conducted in order to compare the range of a speaker standing on the podium and near the entrance to the temple. In both cases, sound levels of "human_singer" were used, defined by SPL at a distance of 1m are presented in Table 2.

Table 2. Sound pressure level (SPL) at 1 m distance from sound source defined for speaker.

|	125 Hz	250 Hz	500 Hz	1000 Hz	2000 Hz	4000 Hz
SPL at 1 m distance, dB	65	68	71	74	77	80

200 000 rays (energy particles) were generated from the sound source. Rays travel on straight lines reflecting specularly from surfaces. Depending on the properties of surfaces, a portion of the acoustic energy is absorbed (proportionally from the sound absorption coefficient, less energy is reflected than hits the surface). Receivers record rays hitting it at a specific time. Based on the record of particles hitting the receivers, echograms are made for each receiver. From echograms, acoustic parameters can then be calculated.

The most important parameter in our case is a Speech Transmission Index (STI), calculated taking into account the reverberation time, the level of speech, and the level of noise. According to IEC 60268-16 international standard, STI between 0.00 and 0.30 is bad, 0.30–0.45 poor, 0.45–0.60 fair, 0.60–0.75 good, and 0.75–1.00 excellent. In the case of Forum Romanum, maps of STI were calculated for all places not occupied by buildings.

A typical spectrum of noise level was applied to the model evenly distributed over all surfaces of receivers. Three different noise levels were applied to compare cases of low level ambient noise, typical audience noise (Figs 2–3), and raised audience noise (Table 3).

Figure 2. Results of STI analysis for speaker speaking from the Imperial Rostra with "typical audience" background noise. Green marks the area with the STI measure of 0.75–1.00 ('Excellent'), dark blue marks the area with the STI measure of 0.60–0.75 ('Good'), light blue marks the area with the STI measure of 0.45–0.60 ('Fair'), yellow marks the area with STI measure of 0.30–0.45 ('Poor').
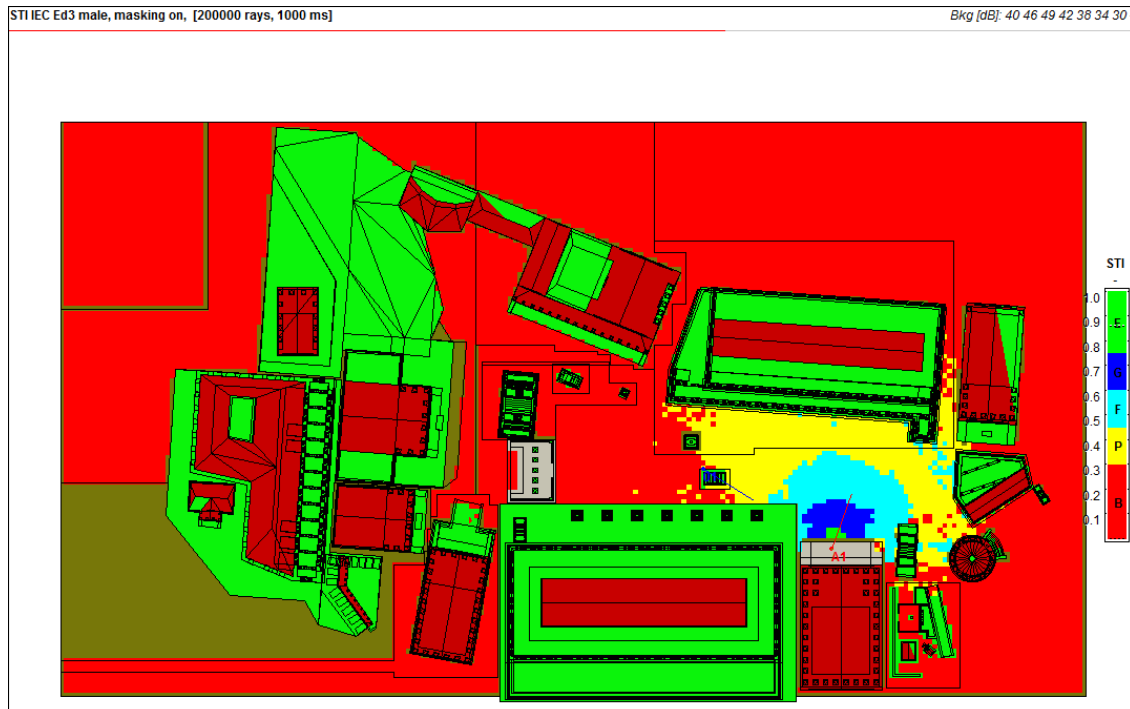
Figure 3. Results of STI analysis for speaker speaking from the podium of the Temple of Castores with "typical audience" background noise. Green marks the area with the STI measure of 0.75–1.00 ('Excellent'), dark blue marks the area with the STI measure of 0.60–0.75 ('Good'), light blue marks the area with the STI measure of 0.45–0.60 ('Fair'), yellow marks the area with STI measure of 0.30–0.45 ('Poor').

Table 3. Applied in calculation noise levels (Vassilantonopoulos & Mourjopoulos, 2003).

	125 Hz	250 Hz	500 Hz	1000 Hz	2000 Hz	4000 Hz	Total dBA
Low-level ambient noise	45 dB	38 dB	32 dB	28 dB	25 dB	23 dB	36 dBA
Typical audience noise	40 dB	46 dB	49 dB	42 dB	38 dB	34 dB	49 dBA
Raised audience noise	46 dB	52 dB	55 dB	48 dB	44 dB	40 dB	55 dBA

Today estimates of crowd sizes are based on image analysis (cf. Ma, Li, Huang, & Tian, 2004; Marana, Velastin, Costa, & Lotufo, 1998; Yin, Velastin, & Davies, 1996). Since it is impossible to go back in time and take a photo of the crowd at Forum Romanum, to utilize this method we used a different approach. We calculated the crowd size using two different methods based on modern observations of the behaviour of a crowd. An average person occupies approx. $0.2\,m^2$. Therefore, in theory we should be able to accommodate 5 persons per square meter. In reality during public meetings the density of the crowd varies between 1 and 4 persons per square meter, sometimes even exceeding the theoretical limit of 5 persons per square meter (Still, 2014).[6] Based on this, first we took a mean of 3 persons (mean density) and multiplied it by areas we were provided by our acoustic analysis. However, since at similar public events the density of the crowd is usually higher closer to the speaker and decreases with distance (Still, 2014), we calculated the crowd size assuming that in areas where the Speech Transmission Index was excellent the crowd density was 5 persons per square meter, where there was good STI there were 4 persons per square meter, and where the STI was fair, there were 3 persons per square meter (moderated density).

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6 However, it is worth noting that the later causes a feeling of discomfort. Therefore, the crowd reaches the density of more than 5 persons per square meter only in special circumstances, or for a short period of time (Still, 2014, pp. 43–44).

5 Results

For mean density and raised audience noise the speech from the podium of the Temple of Castores could have been heard by approx. 357 persons and from the *rostra* by approx. 336 persons. For the same level of background noise, but calculated with moderated density the speech could have been heard by approx. 375 people for the Temple of Castores and approx. 351 for the *rostra*. Only in that case would have a speaker at the Temple of Castores had a wider range than at the *rostra*. The results for the most obvious case, with typical audience noise and mean density are: for the temple 1284 people, and for the *rostra* 1323. With moderated density: for the temple 1383, and for the *rostra* 1423.

As is clearly visible there are some differences in results due to the crowd size calculation method used, but more interestingly, there are also differences between the two places for the background noise levels we assumed as the most relevant, while for typical audience noise, speakers at the *rostra* have wider range independent of calculation technique. For an extreme situation, when all listeners are quiet, with no wind or rain, we calculated a low-level ambient noise case, where 5929 people could have understood the speaker at Temple of Castores, and even 6651 at the *rostra*.

Table 4. Results for the Temple of Castores.

Background noise: raised audience noise (55 dBA)

Intelligibility of speach	STI range	Area in m²	Density (mean) in persons per m²	Results with mean density in no. of persons	Density (moderated) in persons per m²	Results with moderated density in no. of persons
Excellent	0.75–1.00	0	3	0	5	0
Good	0.60–0.75	18	3	54	4	72
Fair	0.45–0.60	101	3	303	3	303
Poor	0.30–0.45	539	3			
		SUM		**357**		**375**

Background noise: typical audience noise (49 dBA)

Intelligibility of speach	STI range	Area in m²	Density (mean) in persons per m²	Results with mean density in no. of persons	Density (moderated) in persons per m²	Results with moderated density in no. of persons
Excellent	0.75–1.00	7	3	21	5	35
Good	0.60–0.75	85	3	255	4	340
Fair	0.45–0.60	336	3	1008	3	1008
Poor	0.30–0.45	1019				
		SUM		**1284**		**1383**

Table 5. Results for the Rostra.

Background noise: raised audience noise (55 dBA)

Intelligibility of speach	STI range	Area in m²	Density (mean) in persons per m²	Results with mean density in no. of persons	Density (moderated) in persons per m²	Results with moderated density in no. of persons
Excellent	0.75–1.00	1	3	3	5	5
Good	0.60–0.75	13	3	39	4	52
Fair	0.45–0.60	98	3	294	3	294
Poor	0.30–0.45	403	3			
		SUM		**336**		**351**

Background noise: typical audience noise (49 dBA)

Intelligibility of speach	STI range	Area in m²	Density (mean) in persons per m²	Results with mean density in no. of persons	Density (moderated) in persons per m²	Results with moderated density in no. of persons
Excellent	0.75–1.00	6	3	18	5	30
Good	0.60–0.75	88	3	264	4	352
Fair	0.45–0.60	347	3	1041	3	1041
Poor	0.30–0.45	963				
		SUM		**1323**		**1423**

6 Summary

The results of our preliminary study of the number of participants in *contiones* who were able to hear the speaker intelligibly in two popular places where these assemblies met show that the podium of the Temple of Castores seemed to be better for maximising the crowd size when the background noise was high than the *rostra* – a place built specifically to function as a speaking platform. However, the situation is reversed when the background noise is low or typical. This shows that this kind of analysis can provide interesting results, enriching our understanding of both Roman oratory and Roman propaganda. Based on our results, it would be interesting to compare the results with an analysis of the old Republican *rostra*. Study of the old *rostra* would help to test the hypothesis that the location of the Republican speaking platform near *Basilica Aemilia* limited the crowd, leading to its demolition by Caesar (Muth, 2014, pp. 306–307).[7] The next necessary step in improving the study is to include computer modelling of variables, i.e., levels of speech, background noise and density of crowds. This would allow better indication of the range of possible results. The results may in turn form the basis for a study of the speed and range of information dispersal in the city of Rome conducted with the use of existing models of information dispersal.

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[7] One must bear in mind that the audibility and *also* the visibility were important factors here (Muth, 2014, pp. 306–307).

References

Badian, E. (2009). From the Iulii to Caesar. In M. Griffin (Ed.), *A Companion to Julius Caesar* (pp. 11–22). Oxford: Wiley-Blackwell.

Bell, A. J. E. (1997). Cicero and the Spectacle of Power. *The Journal of Roman Studies*, *87*, 1–22. https://doi.org/10.2307/301365

Bennett, E. L. (1995). *The speeches of Cicero: context, law, rhetoric*. London: Duckworth.

Berardi, U., Iannace, G., & Maffei, L. (2016). Virtual reconstruction of the historical acoustics of the Odeon of Pompeii. *Journal of Cultural Heritage*, *19*, 555–566. https://doi.org/10.1016/j.culher.2015.12.004

Beristain, S., Coss, C., Aquino, G., & Negrete, J. (2002). Tonal response on the stairway of the main pyramid at La Ciudadela, Teotihuacan archaeological site. *The Journal of the Acoustical Society of America*, *112*(5), 2285–2285. https://doi.org/10.1121/1.4779170

Betts, E. (2011). Towards a Multisensory Experience of Movement in the City of Rome. In R. Laurence & D. J. Newsome (Eds.), *Rome, Ostia, Pompeii: Movement and Space* (pp. 118–132). Oxford: Oxford University Press. https://doi.org/10.1093/acprof:osobl/9780199583126.003.0005

Bilsen, F. A. (2006). Repetition pitch glide from the step pyramid at Chichen Itza. *The Journal of the Acoustical Society of America*, *120*(2), 594–596. https://doi.org/10.1121/1.2213570

Broughton, T. R. S. (1952). *The Magistrates of the Roman Republic, vol II: 99 B.C.-31 B.C.* New York: American Philological Association.

Coarelli, F. (1985). *Il Foro Romano II: periodo repubblicano e augusteo*. Roma: Edizioni Quasar.

Dams, L. (1984). Preliminary Findings At the 'Organ' Sanctuary in the Cave of Nerja, Malaga, Spain. *Oxford Journal of Archaeology*, *3*(1), 1–14. https://doi.org/10.1111/j.1468-0092.1984.tb00112.x

Declercq, N. F. & Dekeyser, C. S. A. (2007). Acoustic diffraction effects at the Hellenistic amphitheater of Epidaurus: Seat rows responsible for the marvelous acoustics. *The Journal of the Acoustical Society of America*, *121*(4), 2011–2022. https://doi.org/10.1121/1.2709842

Devereux, P. (2001). *Stone Age soundtracks: the acoustic archaeology of ancient sites*. London: Sterling Publishing Company.

Devereux, P. & Jahn, R. G. (1996). Preliminary investigations and cognitive considerations of the acoustical resonances of selected archaeological sites. *Antiquity*, *70* (July), 665–666.

Díaz-Andreu, M. & Mattioli, T. (2016). Archaeoacoustics of rock art: quantitative approaches to the acoustics and soundscape of rock art. In S. Campana, R. Scopigno, G. Carpentiero, & M. Cirillo (Eds.), *CAA2015. Keep the revolution going: Proceedings of the 43rd Annual Conference on Computer Applications and Quantitative Methods in Archaeology* (pp. 1049–1058). Oxford: Archaeopress Archaeology.

Döbler, C. (1999). *Politische Agitation und Öffentlichkeit in der späten Republik*. Frankfurt: Peter Lang.

Farnetani, A., Prodi, N., & Pompoli, R. (2008). On the acoustics of ancient Greek and Roman theaters. *The Journal of the Acoustical Society of America*, *124*(3), 1557–1567. https://doi.org/10.1121/1.2951604

Favro, D. (2006). In the Eyes of the Beholder: Virtual Reality Re-Creations and Academia. In L. Haselberger & J. Humphrey (Eds.), *Imaging Ancient Rome. Documentation – Visualization – Imagination. Proceedings of the Third Williams Symposium on Classical Architecture, 2004. (JRA Supplementary Series 61.)* (pp. 321–324). Portsmouth: Journal of Roman Archaeology.

Fazenda, B. M. (2013). The acoustics of Stonehenge. *Acoustics Bulletin*, *38*(1), 32–37.

Gruen, E. S. (1974). *The last generation of the Roman Republic*. Berkeley, Los Angeles: University of California Press.

Laser, G. (1997). *Populo et scaenae serviendum est: die Bedeutung der städtischen Masse in der späten römischen Republik*. Trier: Wissenschaftlicher Verlag Trier.

Lasswell, H. D. (1948). The structure and function of communication in society. In L. Bryson (Ed.), *The Communication of Ideas: A Series of Addresses* (pp. 37–51). New York: Harper and Brothers.

Lubman, D. (1998). Archaeological acoustic study of chirped echo from the Mayan pyramid at Chichén Itzá. *The Journal of the Acoustical Society of America*, *104*(3), 1763–1763. https://doi.org/10.1121/1.424061

Lubman, D. (2002). Acoustical features of two Mayan monuments at Chichen Itza: Accident or design? *The Journal of the Acoustical Society of America*, *112*(5), 2285–2285. https://doi.org/10.1121/1.4779172

Ma, R., Li, L., Huang, W., & Tian, Q. (2004). On pixel count based crowd density estimation for visual surveillance. In *IEEE Conference on Cybernetics and Intelligent Systems, vol. 1* (pp. 170–173). Singapore. https://doi.org/10.1109/ICCIS.2004.1460406

Marana, A. N., Velastin, S. A., Costa, L. F., & Lotufo, R. A. (1998). Automatic estimation of crowd density using texture. *Safety Science*, *28*(3), 165–175. https://doi.org/10.1016/S0925-7535(97)00081-7

May, J. M. (2002). *Brill's companion to Cicero: Oratory and rhetoric*. (J. M. May, Ed.). Leiden-Boston-Köln: Brill. https://doi.org/10.1163/9789047400936

Morstein-Marx, R. (2004). *Mass oratory and political power in the late Roman Republic*. Cambridge: Cambridge University Press.

Muth, S. (2014). Historische Dimensionen des gebauten Raumes – Das Forum Romanum als Fallbeispiel. In O. Dally, T. Hölscher, S. Muth, & R. Schneider (Eds.), *Medien der Geschichte–Antikes Griechenland und Rom* (pp. 285–329). Berlin-Boston: De Gruyter.

O'Donnell, V. & Jowett, G. S. (1989). Propaganda as a Form of Communication.pdf. In T. J. Smith III (Ed.), *Propaganda: A Pluralistic Perspective* (pp. 49–64). New York - Westport - London: Praeger.

Pina Polo, F. (1989). *Las contiones civiles y militares en Roma*. Zaragoza: Departamento de Ciencias de la Antigüedad, Universidad de Zaragoza.

Pina Polo, F. (1995). Procedures and Functions of Civil and Military contiones in Rome. *Klio*, *77*(JG), 203–216. https://doi.org/10.1524/klio.1995.77.jg.203

Still, G. (2014). *Introduction to Crowd Science*. https://doi.org/10.1201/b17097

Taylor, L. R. (1957). The rise of Julius Caesar. *Greece and Rome*, *4*(1), 10–18. https://doi.org/10.1017/S0017383500015643

Till, R. (2011). Songs of the stones: an investigation into the acoustic history and culture of Stonehenge. *IASPM@ Journal*, *1*(2), 1–18. https://doi.org/10.5429/2079-3871(2010)v1i2.10en

Till, R. (2014). Sound archaeology: terminology, Palaeolithic cave art and the soundscape. *World Archaeology*, *46*(3), 292–304.

Vasaly, A. (1996). *Representations: images of the world in Ciceronian oratory*. Berkeley, Los Angeles-Oxford: University of California Press.

Vassilantonopoulos, S. L. & Mourjopoulos, J. N. (2003). A Study of Ancient Greek and Roman Theater Acoustics. *Acta Acustica United with Acustica*, *89*(1), 123–136.

Vassilantonopoulos, S. L. & Mourjopoulos, J. N. (2009). The acoustics of roofed ancient odeia: The case of Herodes Atticus Odeion. *Acta Acustica United with Acustica*, *95*(2), 291–299. https://doi.org/10.3813/AAA.918151

Watson, A., & Keating, D. (1999). Architecture and sound: An acoustic analysis of megalithic monuments in prehistoric Britain. *Antiquity*, *73*(280), 325–336. https://doi.org/10.1017/S0003598X00088281

Weinstock, S. (1971). *Divus Julius*. Oxford: Oxford Clarendon Press.

Yin, J. H., Velastin, S. A., & Davies, A. C. (1996). Image processing techniques for crowd density estimation using a reference image. In S. Z. Li, D. P. Mital, E. K. Teoh, & H. Wang (Eds.), *Recent Developments in Computer Vision* (pp. 489–498). Berlin, Heidelberg: Springer Berlin Heidelberg.