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The Auditorium and the Singer

D.B.FRY

UNIVERSITY COLLEGE LONDON

By way of introduction it is necessary to say a brief word about the interaction between auditorium acoustics and the experience of the listener. In music generally, two factors contribute to this experience; using a visual analogy, we could call them line and colour. It is essential in the performance of a work such as 'The Art of Fugue' that the listener should be able to perceive very readily the lines of the music and so important is this factor that Bach himself never prescribed any colours for its performance. On the other hand, works like Debussy's 'La Mer' and the 'Sea Interludes' from Britten's 'Peter Grimes' depend predominantly on the conveying of musical colour.

From the point of view of auditorium acoustics, these two requirements are, to a considerable degree, opposed to each other. We are all aware of the complex character of auditorium acoustics but if we use a shorthand expression, we can say that relatively short RT and flat frequency response favour the appreciation of line, while a longer RT and some degree of bass reverberance is needed to give a good impression of colour. Each of these two conditions has its attendant drawbacks which become obvious when they are carried to extremes, as the first was, for example, in the initial state of the Royal Festival Hall and the second in the original condition of the Royal Albert Hall. Inevitably every good concert hall presents us with a compromise with respect to the two requirements.

Music and words

We may now transpose this general problem into terms of the singer's performance. No matter what he is singing, with exceptions so rare that they may be disregarded, the singer is required to get across to his audience the notes and words of the piece, on the one hand, and on the other, the melody and tone colour which convey the emotional moods of the composition. Once again the two desiderata call for rather opposed characteristics: articulation of a rapid succession of notes or syllables will benefit from a comparatively 'dry' acoustic while the flow of the melody and the colouring of the tone are made more effective by a warmer acoustic. Naturally everything that is sung calls for a balance between words and music; sometimes the words are of paramount importance, at others they have to be made subordinate to the melody. This is particularly the case in the singing of lieder, where the balance is certain to shift within a cycle of songs and where variety of tone colour is the essence of a good performance. For such a recital the hall needs to present a happy compromise between the acoustic that is good for speech and that which is good for orchestral music. This is one of the reasons why the Wigmore Hall in London is very much favoured by singers (and of course by other performers) and is generally preferred to the newer halls such as the Queen Elizabeth Hall and the Purcell Room. Where the conditions are reversed, life becomes a burden for the singer; in an auditorium with a long RT it is almost impossible to perform a patter song or, for instance, the famous buffo duet, 'Cheti, cheti', at the end of 'Don Pasquale'; equally the long expansive phrases which Verdi writes for every type of voice and in every opera tend to

become exhausting instead of uplifting for the singer in a hall with too little reverberance.

The nature of singing

Up to this point we have taken an extremely over-simplified view of the acoustics of auditoria and of the activity of the singer. There are a number of reasons why it is quite generally accepted that the singer is a rather special kind of musician: the singer has no instrument but himself, he monitors his production very largely through his own skull, he is the only musician who has to emit words as well as music and in general he performs much more from memory than any other musician except the concerto player. The first two of these conditions have an important bearing on acoustics and it will be well to expand on them somewhat. The singer's monitoring of the sounds which he produces is carried out in great measure on the basis of the signal conducted through the bones and tissues of his head, exactly as is the case in speech. The difference between this bone-conducted signal and the air-borne sound which listeners hear is so great that no speaker is able to recognize his own voice when for the first time he hears it recorded. For the singer, this fact gives rise to a basic problem: he is going to produce a sequence of sounds through which he will try to affect his listeners in a variety of ways, principally emotionally, but he himself will not hear what they hear; his only guide is a rather drastic transform of the sounds. While it is true that some element of this effect enters into instrumental performance, the singer's case remains *sui generis* because the whole of his instrument is encased within his body.

The training of the singer, therefore, is directed towards acquiring the ability, not to produce certain sounds, but to perform consistently certain actions which result in sounds. The distinction may seem trivial to those who have never undergone the training but it is in fact a vital one. The function of singing teachers, a somewhat maligned race, is to induce pupils to acquire habits of muscular action of an extremely complex kind, since they involve the muscles of respiration, phonation and articulation co-ordinated in a wide range of different patterns; the teacher acts as the external monitor and must be able, through intuition and experience, to tell what modifications of the actions are called for to achieve satisfactory sounds. Given the indirect nature of the link from pupil to sound to teacher to pupil, it is small wonder that the process has to be carried out largely through suggestion.

None of this implies that singing can be carried on independently of the auditory feedback loop; of course it cannot, and the fed back signal is of primary importance with respect to some dimensions of the tone, for example, its pitch (1) and its loudness. But it does mean that the best results cannot be achieved by aiming at a particular sound. The singer's control of his tone is very direct and largely instinctive-emotional; if he aims for a certain sound or attempts to 'listen to himself', as he is sometimes advised to do by well-meaning music critics, this direct control is interfered with and the lack of genuineness in the output is evident to his audience. One of the marks of the untrained singer, when he tries to do more than enjoy the salutory release of physical and emotional energy afforded by 'a good sing', is that he is trying to produce a good sound without having undergone the discipline needed to learn what actions are required to do this. In his case, the usual result is not a lack of genuineness but rather a complete illusion as to the sounds he is actually producing.

The monitoring of loudness

A reasonable conclusion from this account of what the singer is doing would be that he is not affetced by the acoustic of the auditorium in which he performs. We have already indicated that this is not in fact the case but it is substantially true that the singer who is thoroughly trained and experienced has learned to carry out the required actions so well that he can reproduce them in a very wide range of acoustical environments: in the open air, in the anechoic chamber, in the opera house or in the cathedral. Auditorium acoustics do affect the singer, however, more particularly in his judgment of the loudness of his own output compared with that of any accompaniment, by piano, by other singers or by an orchestra. Singers, like all speakers, are intent on maintaining a certain minimum signal-to-noise ratio, if we may adopt this expression to refer to accompanying musical sounds; when air-borne reflections enhance the singer's own tone, this ratio is at once improved, even though the accompaniment is also being reflected. Where the level of reflected sound is low, there is a strong temptation for the singer to put out more energy than is actually needed and this will lead almost certainly to his being told by his critics, both amateur and professional, that he is 'forcing' his tone. The importance of the relation between the singer's own tone and the accompaniment becomes obvious when we consider, for instance, that the full orchestra playing fortissimo will be putting out well over 90 dB.; the first-rate singer is able to sing in such a way as to be audible above such an accompaniment, but we cannot wonder that he welcomes some aid from reflected sound in doing so. On the other hand he would not choose to pay the price for such assistance, in the way of reduced clarity and definition and the loss of words, demanded by an over-resonant auditorium. Here again the situation of the untrained singer is markedly different: he is working with a relatively inefficient source and naturally welcomes all the help he can get from the room in raising the loudness of his tone. The popularity of singing in the bath is evidence enough of a widespread desire to have the acoustic environment do the major share of the work.

The importance of early reflections

One of the most important features of singing still remains to be mentioned because of its interaction with auditorium acoustics. The voice is the only musical instrument in which the harmonic content of the tones produced can be varied over a wide range at the will of the performer. It is true that this is possible to limited extent with other instruments: the clarinet displays such differences between the chalumeau and the upper register, brass instruments can be played with 'cuivré' tone, and so on, but these harmonic changes are minimal when compared with the great range of colour variation that the well-trained singer has at his disposal. In order to convey the mood of a song or a scene, it is far from sufficient to vary the pitch and the loudness of the phrases in accordance with the printed score; in addition there must be variation in tone colour or timbre, which means in physical terms continual modification of the harmonic content of the tone. The singer is not of course analytical about this; he does not say to himself 'In order to express this mood, I will increase the strength of the harmonics in the range 2000 to 3000 Hz.'. The control is much more direct, from the perception of the mood to the intuitive knowledge of the appropriate actions and hence to the production of the sound which will best convey the mood to the listeners. For this purpose changes in the harmonic structure of the tone often have to be made from phrase to phrase. If the

singer is going to be helped at all in this matter by the acoustic of the hall, it will be the early reflections that will be of assistance, particularly those of high frequencies. The immediate surroundings of the performer assume considerable importance in this context; if the singer gets good reflections from the platform or the stage, this makes life easier for him. Once again one can cite the example of the Wigmore Hall in London, with its curved, panelled surround and domed ceiling to the platform. On the operatic stage there are nearly always some reflections from scenery and hence most singers will prefer to sing at the mid-stage or even upstage level rather than down at the level of the proscenium arch. The high frequency content of the singing tone is of great importance not only with respect to changes of colour but also in the matter of 'riding the orchestra'. No matter what the type of voice, the singer cannot compete on equal terms with the fortissimo orchestra in the low and mid-frequency range, but by accentuating the higher harmonics in the tone, by keeping some 'metal' in the voice, he or she is able to remain audible and distinct even when the accompaniment is very loud.

Like other musicians, the singer and especially the opera singer is called upon to do a great deal of ensemble work; this again becomes difficult or at least uncomfortable if there is a very low level of reflected sound. During the initial test concerts at the Royal Festival Hall, the orchestral players without exception complained that each felt as though he were playing alone, and this of course does not make for good ensemble. The situation has been improved by the later modifications to the hall but the experience certainly demonstrated the importance of reflected sound for ensemble performance. Recent experimental work has confirmed and emphasized this point, showing not only the value of early reflections (2) but also the part played by high frequency reflections, since in an experimental situation performers showed a preference for high-pass even over unfiltered reflections (3). The requirements for ensemble singing are if anything even more stringent because it is often necessary to synchronize consonant articulations as well as keeping the musical beat.

Conclusion

The main problems which face the trained singer in performance are judging the loudness of his own tone in comparison with any accompaniment, varying his tone colour to accord with the mood of the music, articulating words in such a way as not to interfere with other qualities and maintaining good ensemble. His overall acoustic requirement is for an auditorium lying somewhere between that which is good for large orchestral concerts and that which is excellent for speech, but somewhat nearer to the latter, that is with good reflection of high frequencies and a good level of early reflections, particularly in the performance area.

References

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