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The Economy of Choir Size

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THE QUESTION OF APPROPRIATE CHOIR SIZE should be answered with a variety of criteria. According to Ternström, the characteristic sound of an ensemble, which comes from a mixture of the variabilities in frequencies and amplitudes produced by each singer, is met with less than a handful of choir members.[1] Obviously, for SATB scoring, it requires at least four members. For precision tuning of harmonics across choir members, a small ensemble is preferable over a large ensemble.

Aside from special blend and intonation effects achievable by relatively small ensembles, choir size is largely driven by dynamic range and overall loudness, often to match a performance space or an orchestral accompaniment. There are three fundamental ways in which the dynamic range of a choir can be increased: 1) by increasing the dynamic range of each choir member's voice; 2) by increasing the size of the choir; and 3) by decreasing the noise and absorption of sound in the performance environment.

A way to explore the interaction of these three factors is to first imagine a nonreflecting sound environment, perhaps an outdoor venue like a wide open field. The inverse-square law of sound intensity decrease with distance would apply: every doubling of distance from the sound source reduces the sound intensity by 6 dB. For example, if we choose 0 dB to be the sound intensity at 10 meters from the choir, then if we back away to 20 meters, the intensity would be –6 dB; at 40 meters, it would be –12 dB.

In a performance hall, reflections and absorptions from walls and structures make the calculation difficult, but an experiment can be conducted as follows: choir members line up to sing the softest *pianissimo* (*pp*) sound. A listener at an average seat distance from the choir judges the *threshold of perceptibility* in dB. First one choir member sings *pp*, then two, then four, then eight, and so on. When the listener first hears the sound, the threshold is reached. Every doubling of choir members that was needed to hear the sound (2, 4, 8, etc.) adds 3 dB to the threshold of single voice perceptibility, which arbitrarily begins at 0 dB.

Figure 1 shows a graph of choir intensity level versus number of choir members. For the two solid curves shown, every doubling of choir members adds 3 dB to the sound intensity. A threshold of single voice perceptibility of 12 dB is shown, which in this case requires a minimum of 18 voices for a *pp* choir sound to heard, assuming all singers are equal and all sing *pp*.

Now consider the dynamic range of each singer. Here we show a modest 15 dB range from *pp* to *ff*. This suggests a 3 dB increase per dynamic level step, from *pp* progressively to *p*, *mp*, *mf*, *f*, and *ff*. Well trained singers can often

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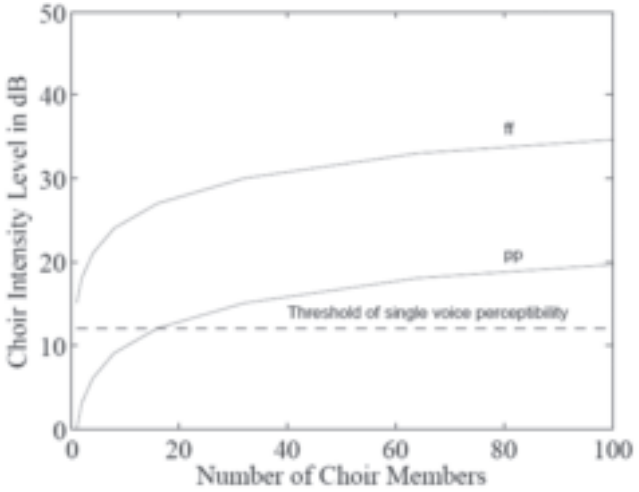

Figure 1. Change of choir's intensity with size.

produce a 20–30 dB dynamic range, which gives the choir the same dynamic range, shown as the difference between the two solid curves. Note, however, how little is gained by simply creating large choirs. Increasing the size of the choir from 18 to 100 singers only adds about 8 dB in overall intensity. This is seen as the difference between the *pp* solid curve and the dashed horizontal threshold line for 18 singers. Furthermore, to use this additional 8 dB for choir dynamics, the choir director must have a scheme for gradually adding and subtracting voices, such as "only every second, third, fourth, or fifth person sings for a soft sound." If performance hall acoustics are improved, however, so that the threshold of single voice perceptibility is lowered, the gradual addition and subtraction of voices may be a useful strategy. Without such fading in and out of voices, however, the graph shows the futility of using large choirs to gain dynamic range.

In summary, choir size can be optimized by testing the performance space and by training each singer to improve his/her own personal dynamic range. Little is gained in dynamic range by increasing choir size beyond about 60 singers. An increase from 60 to 480 (off the chart in Figure 1) produces + 9 dB, a small fraction of what can be gained by individual training of choir members.

NOTE

1. S. Ternström, "Physical and Acoustic Factors That Interact with the Singers to Produce the Choral Sound," *Journal of Voice* 5, no. 2 (1991): 128–143; S. Ternström, "Choir Acoustics—An Overview of Scientific Research Published to Date," *TMH-QPSR [Speech, Music and Hearing Quarterly Progress & Status Report]* 43, no.1 (2002): 1–8.