Proceedings of the Iowa Academy of Science

Volume 17 | Annual Issue Article 27

1910

Some Standardizing Tests of Stern's Tone Variator

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SOME STANDARDIZING TESTS OF STERN'S TONE VARIATOR.

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The tone variator is a closed-tube sound producing instrument. It consists of a cylindrical brass bottle, the bottom of which is a piston controlled by a delicate cog-wheel mechanism. By means of this the depth of the bottle may be readily changed, thus varying the pitch. The sound is produced by a stream of air directed across the mouth of the bottle through a tube set at the proper angle. A pointer attached to the piston's setting gear indicates the pitch in terms of vibrations per second.

The purpose of this study was to determine the reliability of the instrument and how best to manipulate it. It seemed especially well suited for investigations in pitch discriminations. Stern, the inventor of the variator, in an article in Vol. XXX of Zeitschrift fur Psychologie, gives a full description of it and a good general estimate of its practical value. In our conclusions we have not overlooked his estimates, but we have drawn every conclusion directly from records made by the variator itself.

The arrangement of apparatus finally hit upon is as follows: The stream of air is furnished by Whipple tanks. Their pressure is regulated by weights and by a screw clamp applied to the soft rubber carrying tube. A water manometer attached to this tube gives the pressure readings. For reading the pitch of the tone emitted, the tonoscope is used, with a phonette for its receiving apparatus. This apparatus, though quite complicated, is easily managed by one operator, and pitches to a small fraction of a vibration are read accurately.

The variator was first tested as to its behavior under different pressures of the air stream. An increase of pressure causes a rise in pitch. This variation is greatest for light pressure. Thus, an average rise of 6.79 vd. resulted from changing the pressure from 2 units to 3 units, while there was but 2.84 vd. rise when the pressure was increased from 3 units to 4 units. (A unit is one-fourth of the highest pressure that will produce a sound in the variator.) The variation with pres-

sure is greater for the higher pitches. For a pressure increase of from 2 units to 3 units, the rise in pitch was as follows:

Pitch	Rise
200	5.69
250	5.79
300	6.37
350	7.79
400	9.08

The variator is most reliable at the lowest pressure which will cause it to sound. The mean variation at 3 units pressure was 0.70, while at 1.5 units pressure it was only 0.29. The low pressure gives a pure, steady tone, quite free from any pinched or hissing quality.

A similar study was made of the effect of changing the position of the mouth-piece. Raising the mouth-piece above the level of the top of the bottle lowers the pitch. This is greater when the mouth-piece is already in a high position than when it is low. Thus, a change in gap of 3 mm. to 4.3 mm. lowered the pitch as much as a change from 0 to 3 mm. Again, a change in gap from 1.95 mm. to 3.90 mm. caused a rise of 4.80 vd., while a change from 0 to 1.95 mm. gave a rise of only 2.33 vd. The greatest change in pitch that can be made by changing the position of the mouth-piece is about 10 vibrations. The best position for the mouth-piece is the highest that will produce a tone. Set at 0, the results showed a mean variation of 0.6; at 3 mm. gap, a mean variation of 0.4; and at 4.3 mm. gap, a mean variation of but 0.1. There is a most favorable mouth-piece position for each pitch, the higher tones requiring a narrower gap. The wider gap requires a stronger pressure. It is also worthy of note that the 200 vd. to 400 vd. size of variator is most reliable at between 250 vd. and 270 vd.

The manner in which the instrument's mouth-piece is attached is very unsatisfactory. It should be absolutely firm, accurately adjustable, and provided with a setting scale showing the width of the gap. The piston sometimes settles downward. It must be fitted with a clamping device. At the lowest pressures, some tones which give no audible sound, produce a clear reading in the tonoscope. Such tones must be started by the operator's blowing into the variator and starting the general air movement required. The securing of a steady air stream is a serious problem. As noted earlier, the slightest pressure change causes a considerable change in pitch. The Whipple tanks are perhaps the best contrivance, but they demand very close care, and are at best a frequent source of error.

As to the real value of the variator, it can be relied upon only as an instrument of approximate pitch and relative intervals. The fact that its pitch varies with pressure and mouth-piece position, and probably with temperature, humidity, and other conditions makes an absolute reading scale impossible. A variation in one of these conditions would throw any scale out of proportion. But even if it cannot be relied upon for careful quantitative work, it is a desirable piece of apparatus for the psychology laboratory. Its loud clear tone and ready manner of changing pitch make it especially valuable for general class experiments and tests.