THE APPRECIATION OF MUSICAL INTERVALS *

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In a former study (1) it was shown that musical laymen, in judging musical intervals, use the concept 'consonance' as an esthetic qualification, i.e., as a synonym for words as 'beautiful', 'fine', and 'euphonious'. In musicology, however, the concept of consonance is esthetically neutral. Therefore a divergence is present between musicological terminology and common language as to the connotational meaning of 'consonance'.

As may be expected, this connotational difference is accompanied by a difference in denotation: In musicology the ordering of musical intervals according to degree of consonance is different from the ordering a layman makes (1, 2, 3). The most important difference is that, where according to music theory Prime, Octave, Fifth and Fourth are the (most) consonant intervals, the layman gives highest evaluation to Thirds and Sixths (and therefore calls them consonant). Only after these follow Fourth, Fifth and Octave. In fact the Octave is evaluated rather neutral.

For this difference in meaning of consonance historical reasons can be found. The musicological concepts consonance and dissonance did undoubtedly develop on the basis of esthetical considerations, but the scientific terminology stabilized in the Middle Ages, whereas the esthetic conceptions (including the layman's) kept changing. As an esthetic evaluation, layman's opinion on consonance is strongly historically determined. Well-known facts in this connection are for instance the rise in evaluation of the Third in the late Middle Ages (in the Ars Nova the major third was called *dulcis*) and the devaluation of Octave and Fifth (in the 14th century the use of Octave and Fifth-parallels was even forbidden – Joh. de Muris).

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In this paper we call your attention to another determinant in layman's appreciation of intervals, the ear.

That the organ of hearing has something to do with consonance of intervals was hypothesized by Von Helmholtz, among others, and brilliantly explained in his study (4). Although the audiological basis for his (now 100 years old) theory can no longer be accepted without large modifications, we will show that it is still possible to maintain his basic assumptions: (1). Consonance (as an esthetic evaluation) of a pure tone interval is a function of the distance between the tones. Especially for the more complex intervals we expect a lowering of consonance with a decrease in pitch difference of the tones. (2) This function is based on the structure of the peripheral organ of hearing; it is not due to 'central processes'.

To test these general assumptions we derived the following specifications:

(1) If consonance varies with the distance between the tones, one may expect a difference in consonance of narrow and wide intervals composed of pure tones (sine tones) of equal complexity. As narrow intervals we used frequency ratio's 4:5, 6:7, 8:9, 10:11, 12:13, and 14:15. As corresponding wide intervals of equal complexity we used 3:5, 5:7, 5:9, 6:11, 7:13, and 8:15. We expected the narrow intervals to be judged more dissonant, because of the smaller frequency difference.

(2) This expected difference between narrow and wide intervals has to be absent if saw-tooth tones are used to compose the intervals (saw-teeth have a rich scale of upper partials). Compare for instance the narrow interval 8:9 (major Second) and the wide 5:9 (minor Seventh). These saw-tooth intervals may, including the partials, be written as 8:9:16:18:..., and 5:9:10:18:..., respectively. So, the wide Seventh now includes the small distance 9:10 (and this is repeated in the further scala of upper partials), by which its consonance is reduced. Therefore we do not expect a difference in consonance between wide and narrow intervals in this case.

(3) If the expected difference between wide and narrow sine tone intervals has to be attributed to the peripheral organ of hearing, we expect that this difference disappears when the two tones of the interval are presented each to one ear (by way of a headphone). The critical frequency difference at narrow intervals is not given in the ear in this case, but only much more centrally. In this case narrow sine intervals have to be more consonant than in the case of normal mixed presenta-

tion. Furthermore, again wide and narrow saw-tooth intervals will not show difference in consonance under the condition of binaurally separated presentation.

These expectations were tested in an experiment in which eight intelligent musically untrained subjects listened to the mentioned series of wide and narrow intervals. The intervals were presented in random order, intermingled with all kinds of other intervals. Each interval occurred four times in the total series: as a pair of pure sine tones monaurally mixed, as a sine pair binaurally separated, as a saw-tooth pair mixed and as a saw-tooth pair separated. The observers judged each interval on a scale, which gave seven gradations between consonant and dissonant. Their judgements were subjected to statistical analysis.

All three expectations were confirmed (levels of significance all below 2%). Therefore we may conclude that the esthetic evaluation of an interval is connected with the distance between the tones (and their partials) and that the responsible mechanism for this connection has to be placed in the organ of hearing.

About the important question, what the exact relation between tone distance and consonance is, we reported elsewhere (5). Suffice it to say that the relation precisely parallels a recently discovered hearing function: the critical band width (6). Where two tones lie within this critical distance, they compose an extremely dissonant interval, except when the difference is so small that slow beats are produced. However, a small increase of distance induces a sharp rise in consonance, to attain a maximum at about the limit of this critical band. At larger distances consonance gradually falls off to some neutral value. Therefore, the sharpest contrasts appear just within this critical band. We could show that in compositions of H. Schütz and J. S. Bach the distance between adjacent tones always varies in this critical region. Modern composers work in this area, as well. This appeared for example from the analysis of a work of Křenek's. However, he penetrates somewhat further into this band than Bach did. In his turn, Bach goes further than Schütz. There seems to be a historical tendency to produce more narrow intervals in compositions. The peculiar idea is that, if this process continues, at some point distances become so small that consonance rises again.

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