The Relationship between Colour and Music

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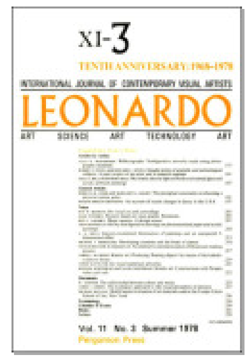

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The pitch or frequency of middle C on the piano is approximately 250 vibrations per second, and that of the C below (mid-baritone) is 125 vibrations per second. Therefore this range, termed an octave, is from 125–250 vibrations per second.

An octave on a piano contains 12 semitones: C, C sharp, D, D sharp, E, F, F sharp, G, G sharp, A, A sharp, B, and C. In the interest of maximum simplicity the following artificial scale is used in which the notes in the scale are equidistant [1], the common interval being 10.416 vibrations per second. Therefore the frequencies are: 125.0; 135.4; 145.8; 156.2; 166.6; 177.8; 187.5; 197.9; 208.3; 218.7; 229.1; 239.5; and 250.0.

The spectrum of visible light ranges approximately from wavelength 0.4000×10^{-3} to 0.8000×10^{-3} mm. For the purpose of this discussion the frequencies can be taken as the reciprocal of the wavelength, giving a range from 1.25 to 2.50 arbitrary units. Multiplying by 100 gives the same range of frequencies as the particular octave on the piano which is selected, i.e. 125 to 250.

There is, therefore, ground for speculation that the eye may 'think' in octaves, like the ear, and that it might be possible to 'translate' an octave of sound precisely into an octave of light. This is particularly so because the eye divides the spectrum into 12 distinguishable colours: red, red–orange, orange, orange–yellow, yellow, yellow–green, green, green–blue, blue, blue–indigo, indigo, indigo–violet, and violet; although many people cannot see indigo as a separate colour.

The figure shows an octave of sound plotted against an octave of light, using the range of frequency units from 125 to 250 in each case. The sound range has been marked with the frequencies of each of the 12 notes in this particular octave and the musical notes indicated. The light range has been marked with the positions of exactly the same frequencies. In colour physics, the spectrum colour is normally thought of in terms of wavelength and not frequency, so in addition, each indicated frequency has been marked with the wavelength corresponding to that frequency.

Using the common delimitations of colour according to wavelength, namely 0.40–0.43 violet (V), 0.43–0.45 blue–violet (BV), 0.48–0.51 blue–green (BG), 0.51–0.55 green (G), 0.55–0.57 yellow–green (YG), 0.57–0.59 yellow (Y), 0.59–0.63 orange (O) and 0.63–0.80 red (R), the colour positions have been added. A colour can be defined equally as a frequency or a wavelength range. It is, therefore, possible to read off from the graph the colour which should correspond to any given note. For example, the note G corresponds to some particular hue of blue–green.

This discussion relates to pure spectrum colours, and not to the colours of artists' paints which result from the subtraction of spectrum colours from white light.

Consequently 'God Save the Queen' should be capable of being translated into colour. The first line of this tune has the notes G–G–A–F♯–G–A, and this would translate into a 'colour tune' as blue–green, blue–green, blue–violet, green, blue–green, and blue–violet. The musical notes are arranged serially in time, and by means of a projector and slides, the colour notes can similarly be arranged.

However, when the supposition is examined in more detail, many problems arise:

(1) 'The Queen' can be played in twelve different keys, one for each semitone, sounding the same in all of them, except for being 'higher' or 'lower' in pitch. However, the 'colour tune' varies very greatly according to the 'key'. The tune for G maj. is given above. For D maj. it is red, red, yellow, dark red, red, yellow. For E maj. it is yellow, yellow, green, orange–red, green. For A maj. it is blue–indigo, blue–indigo, violet, blue–green, blue–indigo, and violet. They eye can not recognise these as having identical frequency steps. The 'colour tune' is different in every key.

(2) When an open string is plucked, in addition to the fundamental note, a series of 'harmonics' is produced, corresponding to the note which would be given by strings having the lengths relative to the original string of 1/1, 1/2, 1/3, 1/4, 1/5, 1/6, 1/7 and so on, with vibration ratios relative to the original string of 1, 2, 3, 4, 5, 6, 7 etc. The sound is therefore very compound, all the notes sounding simultaneously. The differences in 'tone' between different instruments such as the piano, violin, and clarinet are due to different proportional combinations of the harmonics. A 'colour note' does not produce any kind of harmonic effect, although, because of the properties of the eye, it seems to change colour immediately it is looked at (due to a fatigue effect), and also changes slightly according to the background against which it is placed (due to a simultaneous contrast effect). There are several other circumstances which cause the apparent colour (as seen by the eye) to change somewhat. None of these apply to a musical note.

(3) A chord in music is a simultaneous blend of two or more notes, each of which retains its identity to the ear. A mixture of two or more colours gives a completely different resultant colour, sometimes very surprising, e.g. spectrum red with green gives yellow, and spectrum blue

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with yellow gives white. The eye cannot split a colour into its components. The sensation of yellow can be produced in three or four ways.

(4) The simplest musical chord on the piano is the so-called 'perfect fifth' which comprises seven semitones, the notes being separated by 72.9 vibrations per second in the artificial scale shown in the figure. The ear recognises this difference whether the 'fifth' is CG, DA, EB, or FC. They sound alike, and the ear can recognize very accurately whether or not the difference is 72.9 vibrations. This is the basis for tuning a piano, a violin, or a guitar. However, the corresponding 'colour fifths' to the above, are: dark red with green; medium red with indigo; yellow-orange with violet; green-yellow with deep violet. Every 'colour fifth' is different, and the eye cannot recognize them as identical or even similar, although the frequency difference is the same.

(5) In the musical 'common chord' e.g. CEG, the notes are sounded simultaneously in the same 'place' but heard separately. In the corresponding 'colour chord' the colours have to be placed separately in space, for example at the three angles of a triangle, in order for them to be seen simultaneously.

(6) Exploration of the colour combinations corresponding to the more complicated musical chords such as the dominant 7th, 9th, and 13th when arranged spatially, in various juxtapositions, certainly provides some stimulating ideas, but they are only scientifically 'translations' if kept within the same musical 'key' such as C major or minor. Even then, the colour results bear no relationship to the initiating sounds. Scriabin did just as well when he filled his concert hall with coloured lighting selected according to his personal tastes, and his ideas of using perfumes as well, because he liked their smell, were equally soundly based scientifically.

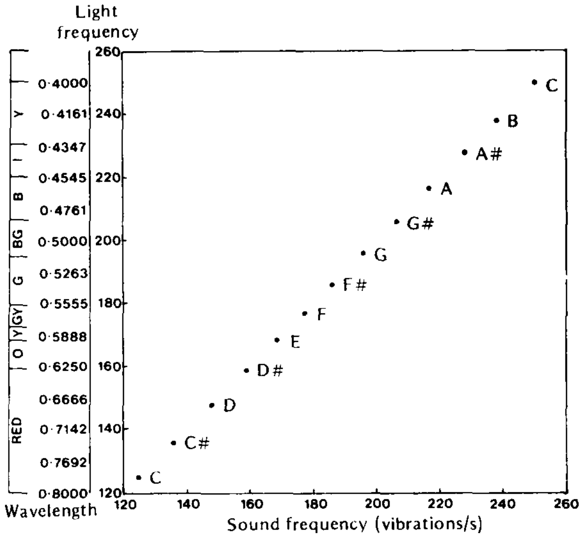

Fig. 1. Relationship between the frequency of sound and colour.

It is always sad when an attractive hypothesis will not stand up to close examination.

Note

1. On a piano tuned to 'equal temperment' the frequency of the upper note of a semitone is the frequency of the lower note times 1.05946 and, therefore, the notes in this scale are not equidistant. If this scale had been used above, there would have been some minor differences in colour descriptions, but these would not in the least have affected the argument.