Experimental sound (MU60011E)
Assessment 2 research folder

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Research Folder Contents:

Disk contents:

Soft copy of the press release brochure
Survey results
Survey analysis table
Printed research folder in PDF format

Bainbridge bishop	- A souvenir of the colour organ
Maarten Franssen	- The Ocular Harpsichord of Louis-Bertrand Castel
H. Von Helmholtz	- Treatise on physiological optics *(.djvu format; reader on disk)*
D.D. Jameson	- Colour Music *(illustrations PDF also supplied)*
Isaac Newton	- Optiks original manuscript I
Steve Zieverink	- Thesis summary PDF

Qu. 13. Do not ſeveral ſort of rays make vibrations of ſeveral bigneſſes, which according to their bigneſſes excite ſenſations of ſeveral Colours, much after the manner that the vibrations of the Air, according to their ſeveral bigneſſes excite ſenſations of ſeveral ſounds? And particularly do not the moſt refrangible rays excite the ſhorteſt vibrations for making a ſenſation of deep violet, the leaſt refrangible the largeſt for making a ſenſation of deep red, and the ſeveral intermediate ſorts of rays, vibrations of ſeveral intermediate bigneſſes to make ſenſations of the ſeveral intermediate Colours?

Qu. 14. May not the harmony and diſcord of Colours ariſe from the proportions of the vibrations propagated through the fibres of the optick Nerves into the Brain, as the harmony and diſcord of ſounds ariſes from the proportions of the vibrations of the Air? For ſome Colours are agreeable, as thoſe of Gold and Indico, and others diſagree.

Qu. 15. Are not the Species of Objects ſeen with both Eyes united where the optick Nerves meet before they come into the Brain, the fibres on the right ſide of both Nerves uniting there, and after union going thence into the Brain in the Nerve which is on the right ſide of the Head, and the fibres on the left ſide of both Nerves uniting in the ſame place, and after union going into the Brain in the Nerve which is on the left ſide of the Head, and theſe two Nerves meeting in the Brain in ſuch a manner that their fibres make but one entire Species or Picture, half of which on the right ſide of the Senſorium comes from the right ſide of both Eyes through the right ſide of both

APPLICATION TO SOUND-MUSIC.

PREPARATION OF INSTRUMENTS.

Piano-forte. — Papers of the several colours, of the different sizes, and in the order specified in the following Table, should be pasted on the keys of each octave of the common piano-forte.* *See Illustration.*

TABLE.

Colours and Semi-Colours, in their order.	Heights.	Widths.
Red. ——— Red-orange. Orange. ——— Orange-yellow. Yellow. Green. ——— Green-blue. Blue. ——— Blue-purple. Purple. ——— Purple-violet. Violet.	Inches. Octave 1——— 2 2——— $1\frac{1}{2}$ 3——— $1\frac{1}{4}$ 4——— 1 5——— $\frac{3}{4}$ 6——— $\frac{1}{2}$ 7——— $\frac{1}{4}$	Whatever the keys will permit.

* A more durable mode is to dye the ivory; but then ivory should be substituted for the ebony now used for the semitonic keys.

The instrument is now prepared. The primary colours, (red, yellow and blue,) and the secondary colours, (orange, green, purple and violet,) are fixed to the keys of their correlative notes in the diatonic scale; and the intermediate semi-colours* to their correlatives, in the chromatic scale.

The order of colours is that of the prism. Their equigradence in *quantity*, to the vibratic gradation in *extent* of the gamut, is preserved, by a decrease in height,† or increase in tenuity, from left to right; to accord with the gradually tenuising tones of their correlatives from bass to treble. The *spacial* length of the colours on the 84 keys is co-equal; which expresses a further, and (at present) *passive* analogy, to the *temporal* length of notes.

The coincidences of colour and sound, in identity of ocular and aural division; and the commensuration of the lateral spacial quantity of the one to the temporal quantity of the other; and also the vertical isometry of

* Not the *tertiary*.

† Table :—Heights.

The resumption of the project

So it is perhaps not strange that nothing more was heard of the ocular harpsichord for ten years. Nevertheless, the instrument kept haunting Castel. When he was reading Félibien's *Entretiens sur la vie et les ouvrages des plus excellents peintres anciens et modernes* and noticed the author's complaint that the theory of painting lagged far behind the theory of music, and his remark that the painter Poussin had also thought about "l'art harmonique des couleurs", he decided to elaborate his invention. There was also the fact, however, that he had increasing doubts on the Newtonian colour scale. It seemed implausible that violet could play the role of fundamental tone, since this colour was in practice always produced by mixing red and blue. Therefore he set out in 1734 to perform a number of systematic experiments on colours, with the assistance of a painter friend. He published his conclusions from these experiments in a 321-page article in the *Mémoires de Trévoux*, in the form of a letter to Montesquieu, who had urged him to make his new ideas public.[29]

Castel's starting point was to take the analogy between the tone scale and the colour scale as literal as possible. Between the two tones that together form an octave, there is a continuum of possible vibration rates, but we discern only a limited number of distinct tones, that is, we interprete any arbitrary tone as one of the twelve notes of the chromatic scale. According to Castel, our observation of colours is subject to the same rule; although all colours continuously merge into each other, we discern only a limited number of distinct colours. Then, if the Newtonian colour scale violet-indigo-blue-green-yellow-orange-red were the true analogue of the diatonic scale, the transition blue-green would correspond to the smallest possible interval E-F, which would imply that we do not discern a separate colour between blue and green. And this, according to Castel, is simply false; between blue and green is celadon. (Observe that Castel here made the mistake of taking the Newtonian colours for the scale in C major, although Newton had compared them with the scale in D minor.) This way of comparing the internal relations of the colours with the tone intervals was the clue to the construction of the true chromatic colour scale. Because red, yellow and blue would surely be part of this scale, it sufficed to determine how many distinct colours there were between red and yellow, between red and blue, and between yellow and blue.

Miraculously, there turned out to be exactly twelve distinct colours: blue-

[29] "Nouvelles expériences d'optique et d'acoustique," *Mémoires de Trévoux*, August 1735, 1444-1482; August 1735, 2me partie, 1619-1666; September 1735, 1807-1839; October 1735, 2018-2053; November 1735, 2335-2372; December 1735, 2642-2768.

The instrument was placed before a sunny window. An electric light could be used behind it.

I had some trouble in deciding how to space the intervals of color, and what colors to use, but finally decided to employ red for C, and divide the prismatic spectrum of color into eleven semitones, adding crimson or violet-red for B, and a lighter red for the upper C of the octave, and doubling the depth and volume of color in each descending octave, the lower or pedalbass notes or colors being reflected evenly over the entire ground. The whole effect was to present to the eye the movement and harmony of the music, and also its sentiment.

The instrument was arranged with a stop so that music and color could be played separately or together.

I cannot say that a musical composition played alone in colors could be recognized by every one; perhaps persons familiar with the instrument might recognize some melodies.

One day while walking I saw a brilliant display of rainbows; around and between these bows the sky was a warm reddish-gray. The whole appearance filled me with an overpowering sense of the harmonic series or chord, as played upon an organ. Why, there were all the colors my instrument gave when this chord was played, with the same number of octaves of color, and in the same order and intervals. The warm reddish glow over the sky was the fundamental C ; the secondary

THE HARMONY OF LIGHT

bow, although reversed, presented the octave and fifth or dominant as its strongest colors (red and greenish-blue); the primary bow to the eye seemed to give four principal colors, red, yellow, — *i.e.,* green-gold, — greenish-blue, and violet, the very same colors my organ gave, and in the same order, when playing the harmonic series or chord; the supernumerary bow on the inner edge represented the higher notes of the series.

When I realized this I was overcome, and felt myself in the presence of a great revelation, for I thought this wonderful display had been placed before the eyes of all humanity since the times of earliest history, and the riddle had not been rightly guessed nor understood.

Men see as they are taught to see. Therefore, to obtain unprejudiced confirmatory evidence to justify this novel view, I have thought it necessary to question uneducated persons and children, whenever a rainbow appeared, and in every instance they have designated the four colors, red, yellow, — *i. e.,* green-gold, — greenish-blue, and violet, and no others. Also, in naming the colors of the secondary rainbow they notice red and greenish-blue as the strongest.

It is true that passing a thin ray of light through a prism shows the intermediate colors, caused by the blending of the four principal colors, red, yellow, — *i. e*., green-gold, — bluish-green, and violet, which in this case would give the seven colors of Newton.

a direct contrast of color comes in as a discord, — for example, a true green and red, or an orange and blue; but if we change the green for a bluish or yellowish green, the effect is much more harmonious. The effect will also be harmonious if we take a violet-red or an orange-red to contrast with green. The same harmonious

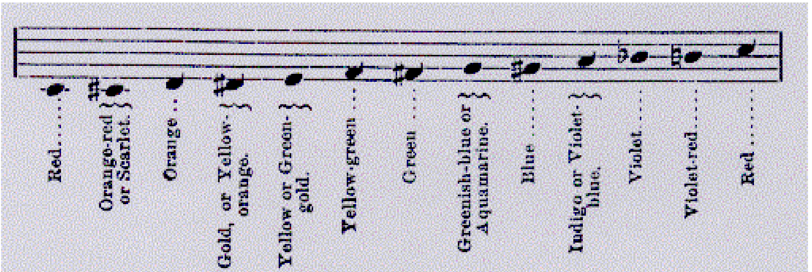

FIGURE 2.

effect will be produced by varying the orange and blue in a like manner. If we wish to make the colors howl, or imitate Chinese musical harmony, we can use crude colors directly contrasting.

The natural harmonic chord of light, as illustrated by the rainbow, shows red as its fundamental or keynote; for this reason I think we should take red for C, the key-note of the natural scale. It will be observed that its dominant is greenish-blue, its subdominant yellow-green. The greens of nature seem to be made up of combinations and masses of greens inclining to these two hues. A pure crude green seems to be out

of place in a landscape, and, if seen, it generally produces a harsh and discordant effect.

The organs which I built, and which were burned, were arranged with stops and pedals. The colors of the pedal-bass could be used as a fundamental accompaniment to tint the ground with the key-note color to show the key or the change from one key to another, or could be used by the musician, at will, to aid the expression of the sentiment of the music. Or the stops could be used to tint all the colors, to show the key or changes of key, and to aid the expression of the sentiment of the music. By use of the stops the color-part of the instrument could be partially shut off, or as much of it used as desirable, at the will of the musician.

I began work on my color-organ in 1875, and spent nearly five years' time studying the subject and building experimental instruments.

My first organ, which I exhibited in New-York, was very crude, and did not show the principle properly. I built two others that were more successful, and showed the principle in a fine manner.

These two organs showed each octave of semitones as a completed prismatic spectrum of colored light, each spectrum blended into other smaller spectrums in the rising scale, and into larger spectrums in the descending scale. The effect imitated the natural spectrums very well indeed, the only difficulty being the